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FULL SPEED AHEAD

It is the patriotic duty of every community and every citizen to transact all the business possible during the war. It is make or break now, and we aren't going to break—it isn't in the blood. Our bank deposits have passed all records. After nearly three years of war Canada is more prosperous to-day than ever before. She is in a stronger position financially than she has ever been; her industries are taxed to keep pace with the demand. Our experience will parallel Canada's, but at a much higher level. The days of uncertainty are over. We have many friends now among the nations, and are in a fair way to "straf" the Kaiser. Just think of those nine dreadnaughts in $9,000,000,000 and keep on sawing wood.

LET PUBLIC WORK GO ON

In times when national emergencies arise, or when general business is actually affected either by an excess or by a deficiency of prosperity there is sure to arise from some quarter the cry that "now is not the time to make public improvements." In 1913 and 1914, when the bread lines in our large cities extended for blocks and materials were plentiful and reasonable, public work slowed down in sympathy with general business. A few far-seeing public officials took advantage of the ample supplies of labor and materials and the corresponding low costs to speed up the work of improvements, but the total net result was a slackening of activity.

In the present situation when the United States is entering upon the most gigantic task in its history, the reactionary public official again comes forward with a seemingly plausible excuse for slowing down or stopping public betterments. A few governing bodies have gone so far as to commit themselves to programs of abolishing certain classes of improvements throughout the duration of the war. The excuse is that all resources of whatsoever character must be at the disposal of the government. It sounds patriotic, self-sacrificing, and grand; it attracts front page position and No. 1 heads in the press; it is a response to the national warning to economize. But it will not, in any large measure, bear up under the scrutiny of an analysis of conditions, and such "economy" measures are rarely accompanied by a reduction in the tax rates.

There are at least three very sound reasons why public work should go on in times like these. First, the slackening or stopping of public work does not, in any significant manner, assist the nation in its preparation for conflict; it may even hinder it; second, a public betterment needed in times of peace is doubly needed in times of war; third, certain industries which have been established largely or solely for the purpose of serving the public in connection with public betterments are adversely affected by such a policy.

It is stated that freight cars can be better employed in hauling materials to the munition factories and the finished product to the seaboard than in hauling paving materials to build roads, or in transporting equipment to carry on drainage work. If a shortage in railway rolling stock exists now, the situation will likely not be better as time goes on. Good highways would do much to relieve congestion on the railways. Food products are, we are told, to be scarcer than usual. Prosecution of drainage work would make available millions of new acres of rich agricultural lands. If our industrial centers and cities are to be crowded with laborers, and if our factories are to be busier than ever before in history turning out munitions and equipment for the armies, there is all the more reason why highways should be built as never before, why drainage should go on, why streets should be paved, why water works, light and power plants, sewerage systems, and public facilities of all sorts should be enlarged to meet the increased demands. But, it is said, the cost of doing these things are so high at present. If costs are to be counted in times like these, it must be remembered that any policy which makes for an accumulation of work to be done in the future is not likely to result in a reduction of costs. The need for public betterments is infinitely greater in times of war than in times of peace, and since the need is greater the justifiable cost is greater.

There are in the United States thousands of firms, the sole business of which consists in supplying materials and equipment which are used in public improvement work. They constitute an asset of great economic value to the country. It is not in the least sentimental to urge their right to continue their usual activities, especially when such continuance will serve so greatly to increase the efficiency, the certainty, and the economy with which the processes directly concerned with defense may be carried forward.

Let the public work go on.

It is a certainty that we will have a labor shortage in this country for years to come. It will doubtless continue after the war and may very easily be worse then than now. Our foreign trade will keep on growing and will call for more and more labor. We will also have our war losses.

American contractors have never had an easier decision to make than that of buying labor-saving machinery now.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

Description of progress, including points on best practice in concrete road construction, as based on knowledge gained by inspection of concrete pavements in various parts of the country.

HELTINGE BREED, First Deputy Commissioner, New York Highway Commission, is our authority for the following description of the actual construction in New York state of 201 miles of second-class concrete pavements, 1:2½:5 mix, a type which is no longer used; and upon the actual construction of 364 miles of cement concrete pavement 1:1½:3 mix, built in the last four seasons. There still remain 127 miles of this type of construction under contract in New York.

Grades.

Grades are still treated differently in different sections of the country. Our original practice was not to exceed 5 per cent., but today we are building them as high as 8 per cent. under certain conditions. Grade seems to be limited only by the ability of the wet concrete to run during the process of construction, by the character of the mix and the kind of traffic to use it. Even on a steep grade, the use of a coarse sand prevents the roads from being slippery; and I believe that brooming of the surface facilitates the traction hold of all classes of traffic. Floating should be at a minimum, as this operation brings the finer particles to the surface, which gives a smooth top.

Accidents on Sixteen-Foot Roads.

In order to obviate the danger of accidents on our 16-ft. roads, we have been widening or mooning out the curves, so that in come cases for those of small radius at the center the actual curve is as much as 22 to 24-ft. wide.

We have also considered it good practice to give the outside of these curves a super-elevation in order to make easier the steering of a car, to lessen the likelihood of skidding, and to insure greater safety in taking these curves at speed. This has been objected to as inducing people to travel round these curves at high speed, but speeding seems to be an inherent mania, unrelated to external conditions, and certain it is that banked curves lessen the casualties resulting from it.

Specifications.

Cracking of a concrete pavement is generally due to the unequal settlement of a poor sub-grade. If the road is to be satisfactory, it is of first importance that a good sub-grade be secured. These we consider the essentials of a good sub-grade:

1. It must have uniform bearing power.

If an old roadbed is to be used it must be scarified, reshaped and rerolled for the entire width of the pavement, removing all large stone to a depth of 6 inches.

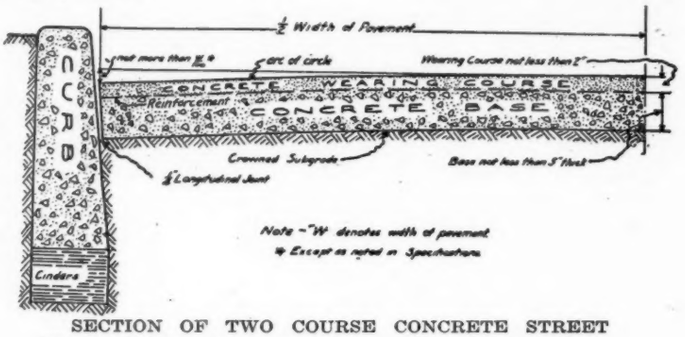
2. It must be dry.

Ditches should be low enough to take away the water from under the pavement. With unstable soil good results can be secured by providing sub-drains and spreading a layer of gravel—preferably run-of-bank gravel—over the sub-grade to increase its stability. Material used for this purpose must be impervious; if it is porous it will act during wet periods as a reservoir, which, under conditions of frost, will break the pavement proper.

3. It should have metal reinforcements.

(a) Under very bad, that is, unequal soil conditions.

(b) Wherever the supporting power of the sub-grade changes, as from rock to earth, or passing over a trench. Our experience indicates that the expense of reinforcement is not justified in gravelly or sandy soils where good natural drainage prevails.

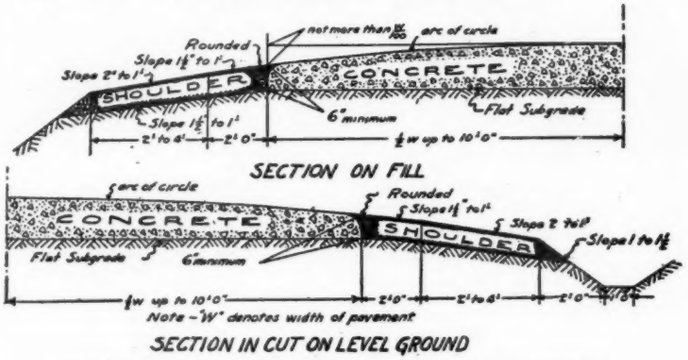


SECTION OF TWO COURSE CONCRETE STREET WITH CROWN AND SEPARATE CURB AND LONGITUDINAL JOINT BETWEEN CURB AND PAVEMENT.

The Mix.

The mix should be proportioned in such a manner as to give the greatest density. With our requirements for materials we have found that the proportions of 1:1½:3 most nearly do this. Our specifications provide that the concrete shall be mixed in the proportions of 1 volume of cement to 4½ volumes of sand and broken stone or gravel, and the proportions of fine and coarse aggregate are varied slightly as a result of field void tests so that the greatest density is obtained. Should the size or character of the materials change there would be a corresponding change in the proportioning of the mixture.

The coarse aggregate should consist of a well mixed product of clean No. 1, No. 2 and No. 3 stone or gravel. No. 1 size is that retained on ⅜-in. circular and passing a ⅝-in. circular screen. No. 2 size is that retained on ⅝-in. circular and passing a 1½-in. circular screen. No. 3 size is that retained on 1½-in. circular and passing a 2¾-in. circular screen.



SECTIONS OF CONCRETE ROAD WITH WELL COMPACTED BROKEN STONE, GRAVEL OR EARTH SHOULDERS.

It is provided, however, that not more than 25 per cent. of the total shall be No. 1 size, the proportions being so graded as to give a minimum of voids.

Aggregates should never be used unless they comply with the tests prescribed.

You may note that we allow, as our maximum size, stone

that will pass a 2¾-in. ring, whereas most specifications permit only 1½-in. stone as a maximum. This may seem radical, but our reasons for the increase in size is that we get equally as good, if not better, results from the larger stone, and at a cost decidedly lessened by our using more nearly the product of the crusher. Especially is the price to be considered on contracts where the local supply is crushed on the ground, as is the case in most of our work. If you desire economy, this change is worthy of your consideration. We save 15 per cent. in crushing costs by this use of stone larger than the previously accepted standards.

From a practical standpoint a pile of stone graded from ¾ to 2¾ inches has more stability when properly mixed than stone graded from ¾ to 1½ inches. In our 1916 work we used stone up to 2¾ inches in size; as an indication of the compressive strength per square inch of field cubes tested at an age of 28 days we have a grand average of 3,370 pounds per square inch for 504 cubes of stone and gravel, of which 13¼ per cent. were under 3,000 pounds. Greater density can be obtained by using stone up to 2¾-in. in size. With the large size stone there is less probability of spalling at joints and along edges.

Tests.

Theoretical tests are fine. They are necessary to tell you what you should have as a final product. You proceed on the hypothesis they offer and then you have to wait until service and climatic conditions prove how far your hypothesis conforms to realty.

Tests for concrete materials have never been given their proper consideration, with the exception of cement, which has been tested with all the finesse of the art of testing. In general little, if anything, has been done on the sands, which have been casually accepted if they looked good or had ever been used before in a structure that would stand up. As for the stone or gravel, all kinds and conditions of both have been used with practically no tests at all.

Our work has shown that if we are to omit any of the tests we might better take a chance with the cement, for of the last 455,000 barrels used, only 1 per cent. failed to conform to the test of the American Society for Testing Materials. Fifty per cent. of these failures was due to flash set and 50. per cent. to failure on the 200 mesh sieve requirement. Had all this cement been used, that rejected for sieve requirement would have given good work, and that rejected for flash set would have been aged enough by the time it was placed in the work to give good results.

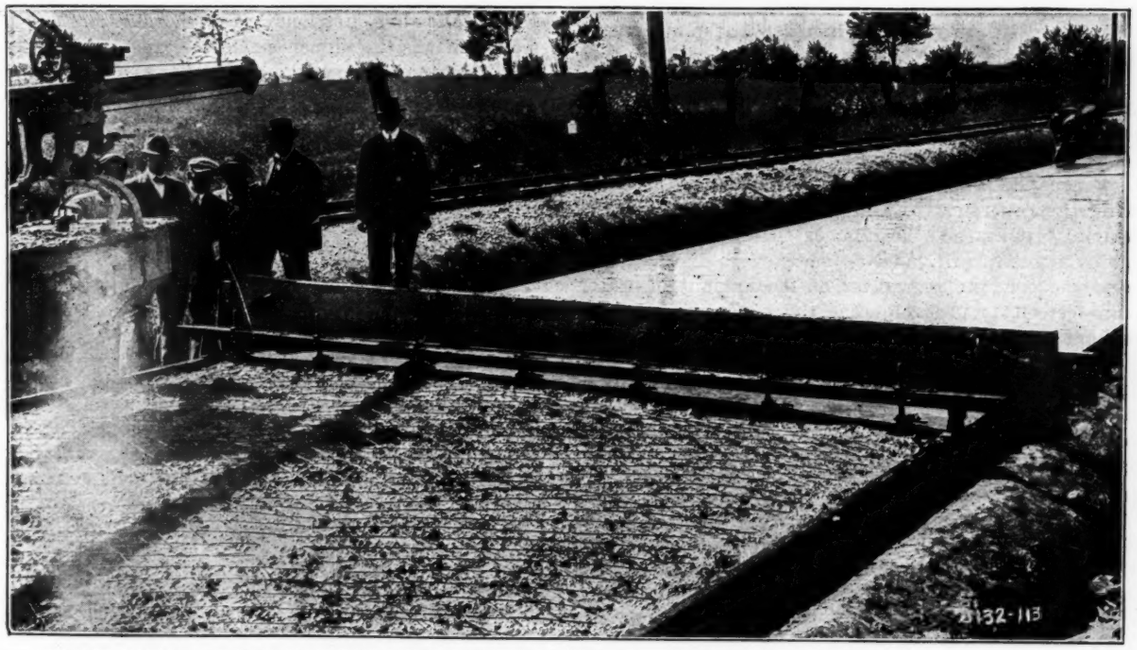
Engineering results presupposes judgment, so why not inject it into our problems? After priming ourselves with theory, let us apply it to practice. Let us make field tests that will parallel laboratory experiments; let us conduct our laboratories in such a way that their value may be significant to the man in the field, and so that their results may be checked up by him. Success of work depends upon the field man; in every case his personality helps determine the results. Put him in line with your tests, practices, etc., and his interest and co-operation will show most profitably in the work. All of our men, from the engineer in charge of the road up are instructed in all of these tests made and methods of inspection, and they complete them on every inspection of the work. We of New York state believe that our best results may be attributed to the esprit de corps engendered by this method.

Effect of Water.

According to Duff A. Abrams, Professor in Charge, Structural Materials Research Laboratory, Lewis Institute, Chicago, water is one of the essential ingredients in a concrete mixture. A certain quantity of water is necessary for the chemical reaction of the cement; a certain additional quantity is generally required for the purpose of producing a plastic mass which can be molded into any desired form.

There are a great many differences of opinion among engineers and contractors as to the influence on the strength and other properties of concrete as the result of differences in the quantity of mixing water used. A thoro experimental investigation of this subject is under way in the Structural Materials Research Laboratory. In the January number of the Concrete Highway Magazine the writer presented a brief discussion on the effect of excess water in concrete. The present article will furnish more definite information concerning the effect of varying quantities of water on the strength of concrete.

The diagram on page 4 summarizes the results of com-



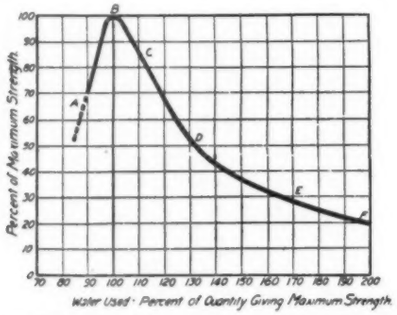
KAHN ARMOR PLATE FOR JOINT PROTECTION, SHOWING SPACES BETWEEN T-RAIL DEVICE AND PLATE WHICH ALLOWS PAVEMENT TO BE FINISHED FLUSH WITH TOP OF JOINT. KAHN ROAD MESH USED AS REINFORCEMENT.

pression tests on 6 by 12-in. concrete cylinders, made in mixes ranging from 1 part cement and 9 parts aggregate to 1 part cement and 2 parts aggregate by volume. These mixes represent concretes of all qualities, from the leanest to the richest, which are used for any purpose. The aggregate consisted of a mixture of sand and pebbles graded in size from the finest particles up to 1¼-in. Exactly the same grading was used in all cases.

These tests show that the effect of proportional changes in the mixing water is approximately the same for all mixes of concrete; consequently a composite curve has been drawn to show the average effect. The vertical distances represent the relative strength of concrete, expressed as a per cent. of the maximum which can be secured from a given amount of cement and the same aggregates. The horizontal distances indicate the relative quantity of water used in the mix, considering the amount which gives the maximum strength at 100 per cent.

The amount of water which gives the maximum strength in concrete produces a mix which is too stiff for most purposes. In plants where such products as building units, drain tile, sewer pipe, etc., are manufactured it is desirable to use a mix even drier than that which gives the maximum strength. The molds can thus be removed within a short time; this would be impossible if a wetter and more plastic mix were used.

It will be noted that the concrete strength increases rapidly with the quantity of water over the range indicated by A-B



CURVE SHOWING STRENGTH OF CONCRETE CYLINDERS.

on the diagram. With any further increase in the amount of water there is a rapid falling off in strength, as indicated by the curve BCDEF. With an amount of water about double that required for highest strength, the concrete has only about 20 per cent. of the maximum strength.

The exact amount of water corresponding to the maximum strength of concrete will vary with the method of handling and placing the concrete. Any method which involves puddling, tamping, rolling or vibration, or the exertion of pressure in any manner, will have a tendency to increase the strength of the concrete regardless of the amount of water used. However, it is probable that the effect produced by these methods will be more pronounced in the consistencies in the vicinity of the maximum strength.

In constructing concrete roads it is necessary to mix the concrete a little wetter than that giving the maximum strength. The consistency which should be aimed at in constructing roads corresponds to about 105 per cent. to 115 per cent. of that giving the maximum strength. In other words, a small portion of the strength must be sacrificed in order to secure a workable concrete. The economies resulting from handling the concrete are more important than securing the maximum possible strength for a given amount of cement.

Many contractors in constructing concrete roads insist on using quantities of water varying between 130 and 200 per cent. of that corresponding to highest strength. The effect of this practice on the strength of the concrete is indicated by the region D-F on the diagram. It is seen that in this case the strength is being reduced to about 50 to 25 per cent of what should be obtained by a proper consistency. It must be apparent that the wearing quality of a road constructed in this way is much inferior to that of a road made from concrete mixed to a proper consistency.

In building construction it is not uncommon to find concrete mixed with a quantity of water even greater than any used in these tests.

Few engineers or contractors realize the disastrous effects which are certain to accompany the use of too much mixing water. We frequently hear the following reasoning:

1. The excess water does no harm because it runs off and evaporates.

2. While very wet concrete is weak at early ages, it gains in strength more rapidly than the drier mixes.

3. The rich mixes used in road construction are less affected by excess water.

Table I.

Mix		Approximate Mix as usually Expressed			Water Required (gallons per sack of cement)	
			Aggregate			
Cement	Vol. of Aggregate after mixing	Cement	Fine	Coarse	Min.	Max.
1	5	1	2	4	6	6½
1	4½	1	2	3	5¾	6¼
1	4	1	1½	3	5½	6
1	3	1	1¼	2½	5	5½

The experimental work as carried out in this laboratory and elsewhere shows that none of these conclusions are correct. The use of excess water produces a concrete which is inferior for all mixes and at all ages. These tests also show that the excess water does not run off until consistencies are reached which correspond to those indicated in the region E-F and beyond. This indicated by the flattening of the curve which shows that the addition of water beyond that indicated by F has little effect. At this point a degree of "slopiness" is reached which gives only about 25 per cent. of the available strength.

The following questions are often asked:

1. What is the proper consistency for concrete road work?

2. How is this consistency to be determined?

These questions may both be answered in a nutshell by saying that for road construction the concrete should contain the smallest quantity of water which will produce a workable mix. It is evident that there may be a difference of opinion as to what constitutes a workable mix, but the diagram above shows that any reduction in the quantity of water within the range which should be aimed at in concrete road construction is accompanied by a rapid increase in the strength of the concrete.

The proper quantity of water will vary with the quantity of cement and the size and grading of the aggregate, and to a less degree on the nature of the aggregate. The water required for a sand and crushed stone aggregate is not appreciably different from that required of a sand and pebble mixture, providing the grading of the aggregates is similar. In case of very soft or porous aggregates (which, however, should not be used in road construction) a somewhat greater quantity of water will be necessary.

The quantity of water required will depend to a minor degree on such factors as the type of concrete mixer, method of placing the concrete, method of finishing, temperature, etc.

There is no direct criterion for determining in advance the best quantity of water for concrete being placed on a road. The concrete should be mixed so that only a small quantity of

free water will appear on the surface after leveling and striking off. This gives concrete of a jelly-like consistency.

The principal difficulty in the way of attempting to determine in advance the proper quantity of water for use in concrete roads is due to the fact that the aggregates are generally damp, and the degree of dampness is not uniform, but varies from time to time. In the case of concrete made of sand and pebbles or sand and crushed stone, well graded in size up to 1½-in., Table I indicates about the quality of water which should be used for mixes which are commonly employed in concrete roads.

This assumes, of course, that the aggregates are in a room-dry condition. Any moisture contained in the aggregates on the work must be taken into account. Most sand piled along the roadside will contain 3 to 10 per cent. by weight of water. In the table the water content is given in terms of gallons per sack of cement. It is not expected that these values will be of general application, since the quantity of water will vary with the size and grading of the aggregate, but they may be found useful in suggesting the limits which should be kept in mind in concrete road construction.

The Use of Side Forms.

The placing of side forms for a concrete road is too often done in a haphazard fashion. According to Mr. J. H. Anderson many forms are not properly constructed in the first place, with the result that they soon bend and warp or wear out of shape. In the second place, side forms are very seldom properly staked to line and grade.

The form setter, as a rule, when he desires to bring a form to grade, does so by inserting beneath it a small stick or stone, which is entirely insufficient to maintain the form to proper elevation under the saw-like pounding action of the strike-

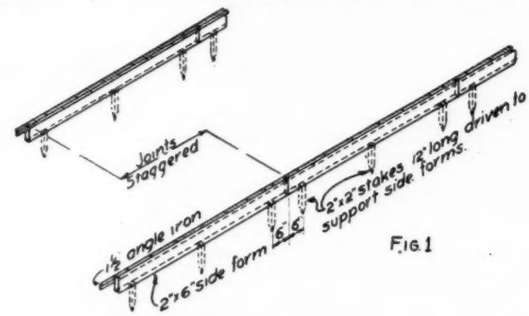


FIG 1

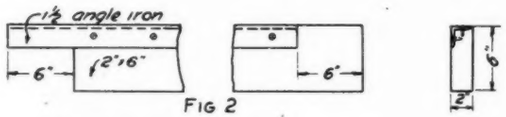


FIG 2

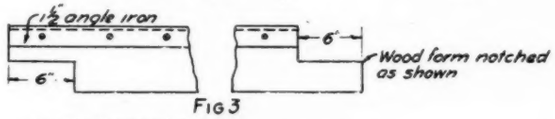


FIG 3

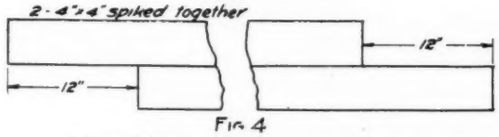


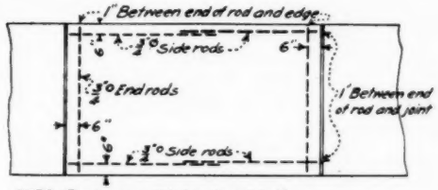
FIG 4

SIDE FORMS FOR CONCRETE ROADS.

board. Frequently, too, the joints in forms on opposite sides of the road are placed directly opposite each other instead of being "staggered," as are the joints on a railroad.

Side Forms for Concrete Roads.

In Figure 1 is shown a method of supporting side forms to grade, which is easily applied. Note that 2x2-in. wooden stakes about 12-in. long are driven along the line of the side forms to the elevation of the bottom of the form. These stakes, of course, are intended merely to support the side form to the proper elevation, other stakes being driven in the regular way for the purpose of holding the forms in line. Note also that the joints in the side forms are staggered to prevent an undulation forming across the road in case the joints should be low. Figure 1 shows the use of wooden side forms with an angle iron at the top edge. This method of staggering the joints and supporting the joints to grade can be applied also to steel forms.


1' Between end of rod and edge
3/4"ø Side rods
6"
3/4"ø End rods
1' Between end of rod and joint
6"
3/4"ø Side rods
NOTE Reinforcement to be placed halfway between top and bottom of slab.

QUANTITIES AND LENGTHS OF ¾" ROUND RODS* FOR 1 CONCRETE SLAB.

DISTANCE BETWEEN JOINTS IN FEET	WIDTH OF ROAD IN FEET								
	18'			20'			24'		
	NUMBER AND LENGTH OF END PIECES	NUMBER AND LENGTH OF SIDE PIECES	TOTAL WEIGHT OF BOTH PER SLAB POUNDS	NUMBER AND LENGTH OF END PIECES	NUMBER AND LENGTH OF SIDE PIECES	TOTAL WEIGHT OF BOTH PER SLAB	NUMBER AND LENGTH OF END PIECES	NUMBER AND LENGTH OF SIDE PIECES	TOTAL WEIGHT OF BOTH PER SLAB POUNDS
25	2 18'-0"	2 25'-0"	129	2 20'-0"	2 25'-0"	135	2 24'-0"	2 25'-0"	147
35	2 18'-0"	2 35'-0"	159	2 20'-0"	2 35'-0"	165	2 24'-0"	2 35'-0"	177
40	2 18'-0"	4 21'-0"	180	2 20'-0"	4 21'-0"	186	2 24'-0"	4 21'-0"	198
50	2 18'-0"	4 26'-0"	210	2 20'-0"	4 26'-0"	216	2 24'-0"	4 26'-0"	228
75	2 18'-0"	6 26'-6"	293	2 20'-0"	6 26'-6"	299	2 24'-0"	6 26'-6"	311
100	2 18'-0"	8 26'-6"	372	2 20'-0"	8 26'-6"	378	2 24'-0"	8 26'-6"	390

* ¾"ø Bars may be substituted, reducing weights to 88½% of those shown.

FIG. 5. PLAN AND TABLE FOR CIRCUMFERENTIAL REINFORCEMENT.

Figures 2 and 3 show details of wooden side form construction. In Figure 2 the angle iron extends 6-in. beyond the end of the form to insure that adjacent forms will be maintained at the same elevation. Figure 3 shows a slightly different design, intended for the same purpose as the form shown in Figure 2. Figure 2 will be bent when the forms are handled roughly and in order to obviate this and still retain the benefits of this design, a form can be built as shown in Figure 3. Figure 4 shows a side form used by a contractor who happened to have a considerable quantity of old 4x4-in. timbers on hand. This side form was used for a road 18-ft. wide and a strikeboard was mounted on wheels. Due to its width, this form was very satisfactory for a strikeboard mounted on wheels, while, due to its rigidity and the method of forming the joints, a very smooth surface was obtained.

Proper placing of side forms costs but little more than does the careless placing all too frequently practiced, and the improved riding quality of the road and the increased satisfaction derived therefrom will compensate many fold for the slight extra expense.

Circumferential Reinforcement.

It has been observed by all who have given close attention to the matter, that where cracks occur in a concrete slab, they begin in most instances at the edge of the slab. Frequently they extend only a few feet. It has therefore been proposed that there should be a certain amount of reinforcement concentrated near the edge of the slabs. This has been designated a cricumferential reinforcement.

While this form of reinforcement has not been used, it makes a strong appeal to all the engineers with whom it has been discussed. It is particularly to be urged in pavements of 20-ft. or more in width; and for pavements 24-ft. wide and over, in additio nto the usual mesh reinforcement.

TRENCH AND TUNNEL EXCAVATION

By J. F. Springer, New York City.

SEWER construction usually entails excavation—sometimes a very considerable amount. But this is not always the case. It will happen, occasionally, that a sewer is to run thru a district where the general surface at the time of construction is known to be considerably below what it is to be after filling in occurs. Or the sewer may follow the line of a ravine, which it is proposed to fill in subsequently. Or, the sewer may cross a valley. Here, instead of excavating, it may very well be that viaduct construction will be necessary. Finally, a sewer may cross a stream below its surface and excavation may or may not be needed. But, after all is said and done, the great bulk of the sewer construction is attended with excavation.

The excavation may be in the open—that is, it may consist of an open cut or a simple trench. It may, however, involve more or less tunneling. As a recent example, involving tunnel construction, may be cited the big Mill Creek sewer at St. Louis. There is an intermediate type of excavation, neither precisely open nor precisely tunnel work. I refer to excavation in large cities where the work may be of such a character that traffic in the street overhead must be provided for while excavation is going on beneath the surface. There may be necessity, in fact, to put in and adequately support planking for roadway use.

The simplest, ordinary type of sewer construction requires the opening up of a trench or open cut. This may be merely an ordinary digging operation. Sometimes, however, we soon encounter rock. Sometimes we find that we have water with which to contend, or it may be earth and water in the form of quicksand. If the trench has anything more than a very insignificant depth, we will often find that we must support the sides of the excavation as well as dig out the material.

The simplest tools used in trench work are the pick and the shovel. Their use is still common. It will be important to be able in advance to estimate the expense of using men with these tools. R. P. Gillette gives, partly on his own authority and partly on the authority of others, certain figures. I excerpt the following in the form of a table:

WORK PERFORMED BY ONE MAN WITH PICK AND SHOVEL.

Material	Cu. yds. handled in one hr.
Hardpan	0.33
Common earth	0.8 to 1.2
Clay (stiff)	0.85
Clay	1.00
Sand	1.25
Sandy soil	0.8 to 1.2
Clayey earth	1.3
Sandy soil (frozen)	0.75

Such figures must be used with discretion. For one thing, the type of laborer to be used and the character of the immediate supervision play important modifying influences. At the same time the foregoing figures afford us a fair guide. It will be understood, perhaps without my saying it, that when the trench gets quite deep the shoveling will naturally slow down. To shovel loosened material into wagons may be done at the rate of 2.3 cubic yards per hour; but this is to be regarded as exceptionally good work and not to be depended upon ordinarily. A lower rate, say 1.8 cubic yards per hour, will cover the general case better.

The Horse and Plow.

Instead of the pick and shovel, the horse and plow may often be used at the beginning. Undoubtedly, wherever the use of the plow is practicable, money may generally be saved. To be effective, the plow must move over some little stretch. Naturally its use will be discontinued after it has penetrated a short distance down. It is understood that a two-horse plow with one man to drive and one to manage the plow is more economical than a one-horse plow. Four-horse and even six-horse teams may at times be advantageous. But, whenever extra men would have to ride the plow team, a steam roller or a traction engine may prove more economical.

The plow drawn by horses or other means is very useful in opening up a trench where the surface is part of a paved street, where it consists of very hard and compact soil or where the soil is frozen. Hand methods in such cases are scarcely economical. Frozen soil may sometimes be drilled and blasted. This will depend largely upon the question of safety to people and property in the neighborhood. If the plow is, for any reason, unavailable for removing frozen soil, we may thaw out the soil by fires built during the night.

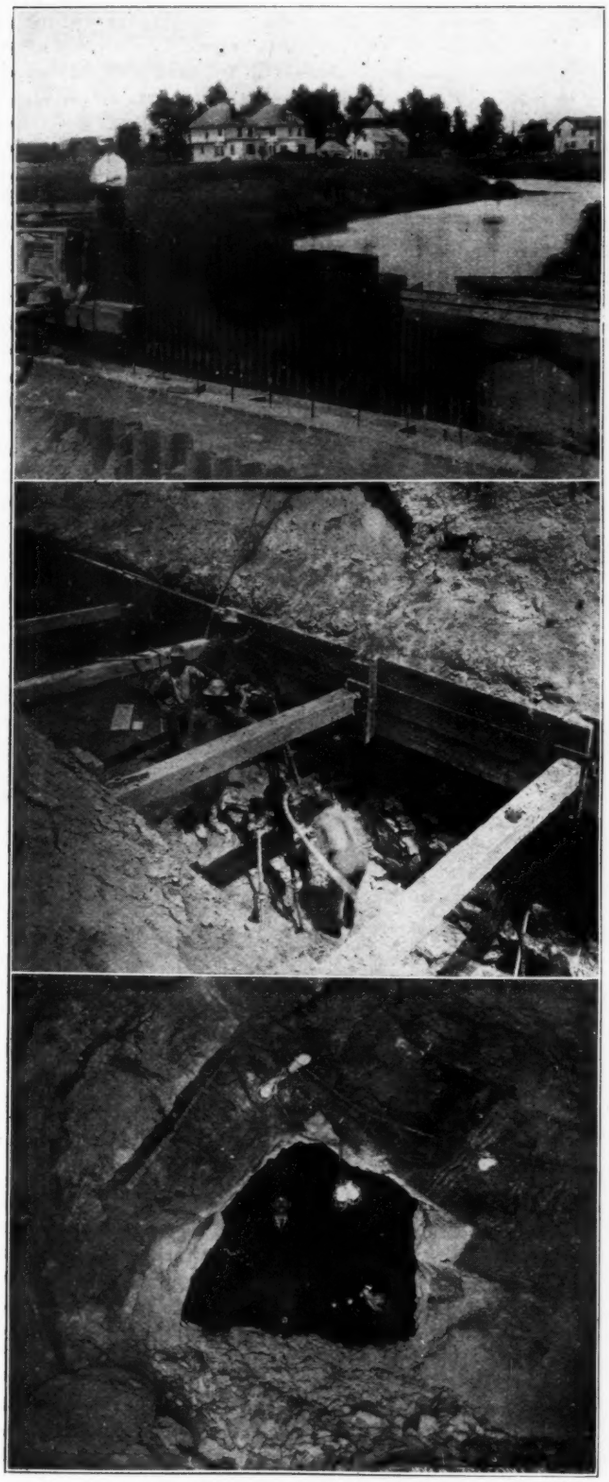
The Use of Steam.

A more elaborate, but probably more effective, method is to thaw out frozen ground by the aid of live steam. The steam may be applied in the following way: A number of tight wooden boxes are prepared, each box having a height of 10 or 12 inches. The length may be a dozen feet or more.

EXTENSIBLE BRACES IN PLACE IN A TRENCH EXCAVATION.

These boxes have their bottoms open. When placed in position, they will form a line of covers for whatever length of trench it is proposed to treat during a single night. The tops of the boxes should be pierced by holes of a size to just permit the introduction of a ¾-inch gas pipe. The holes should be distributed over the top, one being provided for about every two square feet of surface. Along the sides of the boxes, earth should be banked to provide a seal against the escape of the steam or warm air, with which the boxes are to be filled during the thawing operation. A steam boiler will be located nearby and a flexible connection arranged of sufficient length to permit the steam to be transmitted to all points along the row of boxes. To the further end of the hose, a piece of gas pipe, perhaps half a dozen feet long, will be fitted. The holes in the boxes should all be provided with plugs. When all is ready, the man attending to the thawing will

remove a plug and introduce the gas pipe, the latter being provided with a suitable cross-bar securely attached, to facilitate handling and working the pipe. The workman holds or sets the pipe vertical with its open end in contact with the frozen ground. The steam will at once begin its work of thawing. As the thawing goes on and the ground softens, the workman will be able to work the pipe down into the ground and thus thaw it out as far down as desired. When he has dealt with the soil to the full depth at one of the holes, he withdraws the pipe and plugs up the hole. He now attacks the soil thru another hole, and continues the thawing until the work is complete from one end of the row of boxes to the other. It is understood that one man will be able to thaw out in the neighborhood of 35 cubic yards of frozen material in one night. This man will also care for the boiler. The service performed by the boxes is to maintain a warm blanket over the surface being treated.



VIEWS SHOWING FEATURES IN UNDERGROUND CONSTRUCTION: 1—LIGHT WEIGHT CORRUGATED SHEET STEEL PILING AS USED IN TRENCH WORK; 2—TRIPOD DRILLS IN DES PERES (ST. LOUIS) FOUL WATER SEWER; 3—MEETING OF HEADINGS IN HUDSON RIVER SIPHON TUNNEL. POINT SHOWN IS BENEATH RIVER NEAR WEST POINT, N. Y.

The Wakefield Pile.

Sometimes the soil will maintain itself in a vertical wall without aid. But, even in such cases, no deep trenches, except sometimes in rock or the like, should be excavated without adequate protection being provided against the falling in of the side walls. It is best to take absolutely no chances, because the matter involves safety to life and limb. The maintenance of the side walls is provided for by the use of steel or wooden sheeting. In either case, the individual sheet piles may often be driven down to full depth prior to excavation. Under other circumstances, the sheeting will be put in after the excavation is partially done. Wooden piling may consist of simple planks standing side by side, the planks in a vertical position. The thickness will be determined by the service to be performed. That is to say, if the pile has to be driven in advance of excavation, it will have to be stout enough to withstand the driving operation as well as strong enough to resist any horizontal pressures from earth and water. If the service to be performed by wooden sheeting is very exacting, Wakefield sheet piles may be used. These provide a tongue-and-groove interlock, which assists in mantaining the wooden wall as a whole and excluding water from entering the trench from the strata back of the piles. This type of sheet pile may be readily made on the spot, and there is no question of patent infringement. To make a Wakefield pile, we may spike together three planks, all of the same thickness and the same width. The top plank is placed precisely over the bottom one. The intermediate plank parallels the others, but it is displaced somewhat to one side, thus providing a tongue on one side of the pile and a groove of equal depth on the other side. To drive this pile, we sharpen the end which is to pilot the penetration and use any convenient method of pile driving that may be available at the time. While this sheeting has a good, serviceable interlock and may be counted upon for a fair degree of watertightness, still the interlock does not secure the piles in all horizontal directions. That is to say, earth and water pressures from behind may produce a bellying action resulting in the parting of the interlocks at various points. However, this may usually be prevented by adequate bracing.

Sheet Steel Piling.

The best types of steel sheet piling now on the American market have ordinarily an interlock of such character that it will resist opening up in consequence of horizontal pressures. Some of these types may be made quite watertight, if desired.

Sometimes, especially if the soil is dry, the sheeting need not extend to the bottom of the trench. At other times, it will be advisable to run the bottoms down below the level of the excavation. Where sheeting is used to exclude water as well as safeguard the side walls, it will sometimes be advantageous to drive it down until the feet of the piles have well penetrated into an impervious stratum. We may in this way often succeed in cutting off practically all water, the sheeting itself excluding the water from horizontal entrance and the stratum of clay or other impervious material preventing it from coming in from beneath.

Steel sheeting may be gotten almost any length. Unspliced

steel sheet piles 72 feet in length were used at New York in constructing the open cofferdam for excluding the Hudson River from the waterfront at Forty-sixth street. Long lengths may be made up by splicing, this operation being done during the driving. With wooden sheeting, approved practice would seem to limit the lengths of the individual piles. Considerable depths of ditch may be realized, however, by a kind of splicing. That is to say, the trench will be carried down at various widths, the width narrowing as one goes down. An unspliced pile is alloted to each stage. Thus, at Louisville, Ky., a deep sewer trench was put down in three stages. Ten and twelve foot piles were used with overlaps of 14 inches. The trench was 6 2/3 feet wide at the top, 5 1/3 feet through the final stage. At the overlaps, wales or rangers were interposed between the two overlapping walls of sheet piling. At a short distance below such an overlap, a line of wales was arranged.

The braces which are used to hold the wales up against the wooden or steel walls may be simple sticks of squared timber or they may be special braces capable of being lengthened and shortened while in position. Such special braces are obviously convenient.

The sheet piles will be driven more or less in advance of excavation or simply placed against the side of the trench after it has been dug at least to a depth equal to the length of the piles. In this latter case, it is very necessary to trim the sides of the excavation to a plumb line in order that the sheet pile may bear throughout its length.

Short Vertical Pieces.

A modified form of vertical sheeting is where short lengths are used, these being placed subsequent to the excavation of the region they are to protect. An advantage consists in the fact that the excavation need not be carried far without protection for the side banks already dug. Such short vertical pieces are sometimes called poling boards. It may at times be possible to use only a single line of wales to a stretch of such short pieces; but at other times two lines may be required. Poling boards afford an easy, cheap method of shoring. There is a disadvantage, however. In case material slips away from behind the poling boards, they may give way and cause an extensive break-up of the shoring.

Before leaving the subject of sheeting, braces, etc., it may be as well to call attention to the advisability of using cleats with wall braces as a protection against the braces falling.

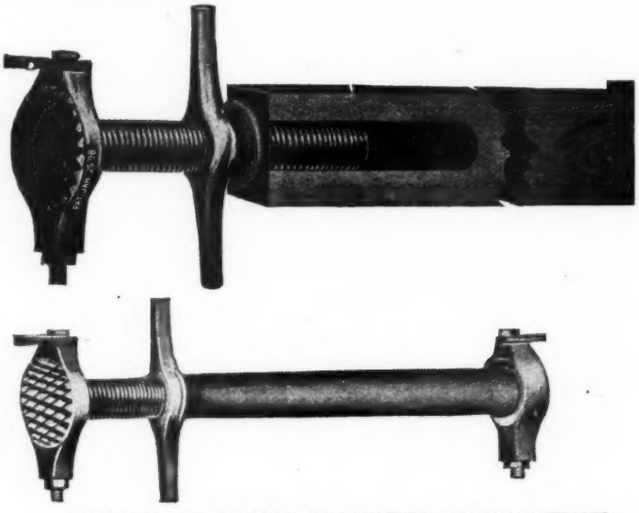
The sides of a trench are sometimes protected by the use of wooden planks laid horizontally. This method has certain advantages. In the first place, we maintain a protection to the walls only a matter of inches behind the excavation. We need excavate but a little, when an additional plank may be put in. Further, it is not so necessary to maintain absolute verticality of the sides of the excavation, as the planks may readily accommodate slight deviations. This type of sheeting is sometimes termed *box sheeting.*

It will readily be seen that extensible braces are especially adapted for use with horizontal planks, as they readily take care of moderate variations in the horizontal distance from plank to plank across the trench. The cross braces may be put in temporarily to secure a single plank on the two sides. Later, vertical strips may be used to cover several planks and the number of braces reduced by arranging them to bear against these strips and not directly against the planking.

Extension Braces.

Extensible braces are valuable not only because they are convenient and tend to expedite the work but also because they eliminate the necessity of hammering and thus producing shocks to which the sides of the excavation may be more or less susceptible. This is to say, when we screw up an extension brace in order to make it press against the planks or strips or wales against the walls of sheeting, we are tightening the brace in a gentle manner; but when we drive in a wedge at the end of an ordinary brace, we may produce shocks which have objectionable results.

Sometimes, tho perhaps not so very often, sheet piling with a good interlock will need no cross bracing or other special means of holding it against earth and water pressures. The piling itself has a degree of stiffness which is naturally increased by the secure interlock. As a rule, longitudinal braces—that is, *wales*—will be used. Cross braces may be put in to brace one wall against another. With piling driven a short distance below the trench bottom, the wales and cross-braces may often be omitted in the bottom part of the excavation. This may be quite an important thing, as such omissions leave free working room. It may often be desirable to have no cross braces at all. There is a way to omit them, even where the earth and water pressures are severe, but it is not conveniently applicable to all cases. Sometimes it may happen that the region to either side of the trench is to receive a fill. It may then be possible under these circumstances to locate "dead men" sufficiently off to either side of the trench to give them proper resistance and to tie the wales to these "dead men" by steel rods provided with turnbuckles. The "dead men" may be held in position by surrounding them with conical piles of earth and rock. Naturally, the "dead men" will be set up vertically or obliquely in order that more than one line of wales may be tied back to the same "dead men." Of course, if only a single line of wales is to be used to each wall of sheeting, then the "dead men" may be laid horizontally.



SPECIAL EXTENSIBLE BRACE FOR USE IN TRENCH WORK. NOTE THE LUGS FOR PREVENTING BRACE FROM FALLING ACCIDENTALLY.

Horizontal "Dead Men."

It is not absolutely necessary that the point of attachment of a tie rod to a wale and the point of attachment to a "dead man" be both at the same level. This makes it possible to use horizontal "dead men," even where there is more than one line of wales to a wall of piling. It also makes it possible to locate "dead men" at up-hill and down-hill positions.

Indeed, a line of "dead men" may be used whether the general surface is horizontal or slopes up or down from the trench. A "dead man" may be set partly in a pit and partly outside. It should be remembered when using oblique tie-rods that they need to be heavier than horizontal ones to withstand the same horizontal thrusts.

The foregoing facts as to the possibilities of eliminating cross braces is important, as such elimination gives a free, unobstructed trench.

(To be continued in August issue)

Vermilion County Highway Improvements

Engineers' and Contractors' Methods Described by Mr. P. C. McArdle, Chief State Highway Engineer and Superintending Engineer, Vermilion County (Ill.) Board of Supervisors.

OUR ENGINEERING force, comprising the engineers division, worked up the estimates, each on his own division and checked the estimates of another division. All end areas were calculated by the use of the planimeter, from cross-sections made every 100 feet, and the cubical contents by a comptometer. These were checked by slide rule; all operations were checked at least once. Our division engineers are called together frequently and instructed in their duties before going into the field.

Each engineer is furnished with a transit equipped with level bubble, level rod, steel tapes, thermometer, scales, a set of sand and a set of gravel screens, field books, loose-leaf note books and such other supplies as he might require. A record of instruments and supplies received by each engineer, is filed in the office and charged against him till their return. The bookkeeper keeps the record of auditing the purchase of all supplies; prepares all vouchers for presentation to the County Auditor, and our committee for approval and payment. The assistant engineer receives, examines and files all reports.

Testing of Cement.

All cement is tested by the Pittsburgh Testing Laboratory under contract with the county. Complete tests are made on each carload in accordance with circular No. 33, United States

PAVEMENT LAID 1916. PAVEMENT TO BE LAID 1917

DIVISION	NO DAYS PAVING 1916	LIN FT PAVEMENT LAID 1916	AVERAGE LIN FT PER DAY 1916	TOTAL LIN FT PAVEMENT IN CONTRACT	NO WORKING DAYS 1917	LIN FT TO BE LAID 1917	AVERAGE LIN FT PER DAY 1917
1	55	22135	402	105204	125	83069	664
2	57	14230	250	106040	125	91810	735
3	112	26843	222	95369	125	68526	548
4	106	57312	541	69785	125	12473	100
5	87	47370	544	97529	125	50159	401
6	4	608	152	90548	125	89940	719
7	75	27003	360	96102	125	69099	553
8	89	38506	421	103776	125	65270	522
9	91	28225	312	111817	125	83592	668

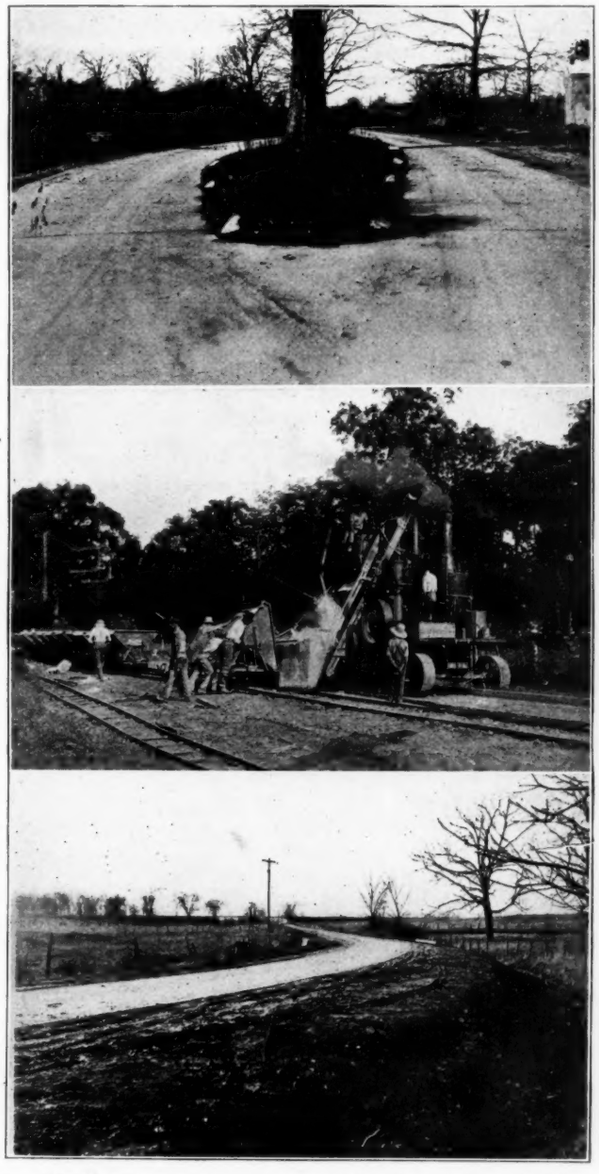
Bureau of Standards. The company notifies the division engineer promptly upon the acceptance of a car of cement. Complete test reports are sent, one to our own office, and one to the State Highway Engineer. In order to check upon their tests, samples from each tenth car are submitted by the division engineer to our own laboratory. In addition, the State Highway Department independently samples and tests this material. All sand and gravel are examined upon receipt

STATUS OF WORK IN MILES, DECEMBER 9, 1916

DIVISION	EXCAVATION	SUB-GRADE	COARSE AG	FINE AG.	PAVEMENT	SHOULDERS	ROAD COMPL
1	11.00	6.25	4.87	4.41	4.41	3.57	
2	4.10	3.06	3.06	3.06	2.68	2.50	
3	6.42	5.17	5.12	5.12	5.12	4.19	
4	13.09	10.81	10.81	10.81	10.81	7.39	7.39
5	9.11	9.11	9.11	9.11	9.11	6.09	2.00
6	4.00	0.75	0.12	0.12	0.12		
7	6.25	5.17	5.09	5.15	5.12	4.70	3.13
8	14.50	7.35	7.35	7.35	7.35	5.50	4.81
9	5.45	5.45	5.45	5.45	5.36	0.50	0.50
TOTAL	77.92	53.12	50.98	50.58	50.08	34.44	17.83

by the division engineer, and in case of dispute between him and the contractor, samples are sent to the office for test. The crushed stone received is tested by our inspector before shipment, and 941 cars were so tested this year.

Tests are made on each car load of paving brick received on the work. The brick are loaded at the plant by the brick company under the direction of our own inspector, who also selects ten samples from each car shipped. These pieces are tested separately and reports are made to the State Highway Department on each car, and a copy is kept in our own files. The brick are also inspected by the division engineer or local inspector on the job.



SCENES ON VERMILION COUNTY BOND ROADS: (1) PAVING DIVIDED TO PRESERVE TREE; (2) SIDE LOADING MIXER IN OPERATION; (3) STRETCH OF ROAD RAISED AND PAVED.

Every safeguard known to the engineering profession is used to insure that the county receives the best possible quality of material of every character required by the specifications and contract.

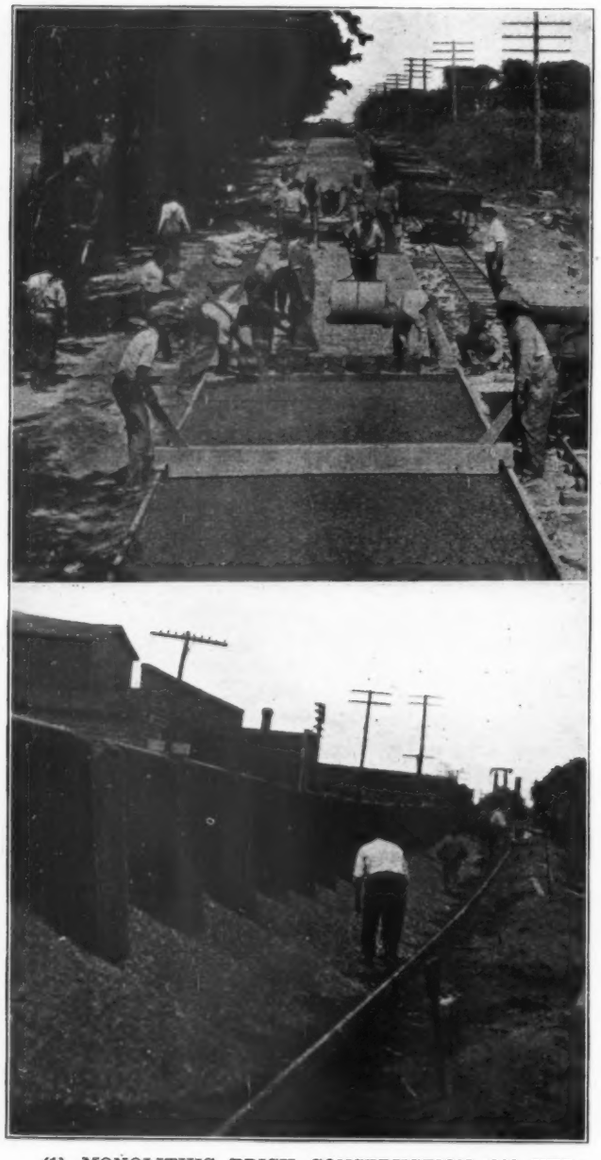
Laboratory Work—Season 1916.

Material	No. tests Bond Roads	No. tests for Co. Supt. Highways
Cement	35	20
Sand	23	3
Stone	6	..
Gravel	18	4
Shoulder Material	15	..
Brick	132	52
Total	229	79

Cement tests from each car by Pittsburgh Testing Laboratory, 455 tests; stone tests by inspector at plant of Brownwell Implement Company, 941 tests.

Method of Constant Inspection.

As previously stated, the division engineer acts as inspector of the materials and workmanship of his division. The superintendenting engineer took upon himself personally, to travel over the work in every division at least once in each week, and as much oftener as each occasion demanded. This involved his traveling from 50 to 150 miles each favorable day, making in order to accomplish this purpose, over 14,000 miles during the working season.



(1) MONOLITHIC BRICK CONSTRUCTION ON VERMILION COUNTY ROAD; (2) DUMPING TRAINLOAD OF STONE FOR DIVISION NO. 4.

The State Highway Department, also furnished a resident engineer, in charge of inspection of the county road work, who also constantly traveled over the work in a Ford touring car inspecting the work for his department. These men were given every facility by our engineers to examine into our methods of inspection and to offer suggestions for the better performance of the work.

Contractors Methods.

All contractors, with one exception, use some unloading machine. Two are using Byers Auto Cranes with clam-shell, two belt conveyers, one stiff-legged derrick with clam-shell, one a cable and bucket, two locomotive cranes and one is unloading by hand labor.

Contractors, by study of the topography of the county thru the use of grade maps furnished by our office determined that the hauling of material by industrial railway was the most practical method of getting material to the jobs. This is evidenced by the fact that seven of the nine contractors are using this method of haul.

All are using storage bins in connection with unloading devices. All of these outfits have given satisfactory service, tho the stiff-legged derrick and locomotive cranes give the wider range of usefulness, being capable of unloading into stock piles, direct into cars, or into storage bins as occasion demands.

Weekly Charts.

Weekly charts of the work are prepared by our division engineers. These are mailed to the office on Monday of each week. Copies are made. One for each division is posted on the bulletin board in the office, and one of each is mailed on Wednesday to the State Highway Department at Springfield, so that the officials may be constantly advised of the progress of road work in the county. A weekly blue print tabulation also is prepared for the use of the chairman of the committee and the superintending engineer.

From time to time, there was prepared and sent to contractors, a tabulation showing the daily average work done to date and the daily work necessary to complete the several contracts within the specified time. These reports show that a little over 50 miles of pavement were placed during the year, and that in addition, 28 miles of excavation were made in preparation for 1917 work. Of the mileage completed, 43 miles were of concrete and 7 miles of brick and of this mileage the State Highway Department has accepted and taken over the maintenance.

Side Loading Mixers.

On divisions 3 and 8, the contractors, A. D. Thompson Company, and P. M. Johnston Company, arranged to use side-loading mixers and dump the concrete materials direct into the mixer hopper. The method is satisfactory from the standpoint of the county in that mixed materials are discharged from the drum without an admixture of clay or loam, which is difficult to avoid when materials are dumped upon the subgrade and later shoveled into the mixer. The disadvantage of the method is the delay due to derailments or accident to unloading outfit, when all work stops till repairs are made, while with the older method, materials may be stored on the subgrade miles ahead of the mixer and when accidents occur, the mixer may still be operated on full capacity while repairs are made to the hauling or unloading outfit. Similarly, when accident occurs to mixer outfit with direct loading, all the outfit is tied up again till repairs are made, while with the dumping on subgrade, hauling and unloading outfits continue work till the mixer is repaired. A photograph shows one of these mixers in action on division 8.

Efficiency Methods in Street Cleaning

How New York City Lowered Costs While Extending Service and Increasing Wages.

INCREASING service and wages while lowering costs is the proud record of the department of street cleaning of the city of New York. This record, made and sustained during the last three years, rests upon root and branch improvements in organization, equipment and methods.

Outstanding Feature in Brief.

Some of the salient features in this fine record of better results at lower costs are: Clean street area increased; cost of regular work in 1916 lowest in six years; increase during last three years of $26 in the annual wage of the employe over that of the preceding three years; collection service improved; per capita cost lowered 26 cents per annum; total saving to city in three years, $1,143,000; 4.43 per cent. increase in amount of ashes, garbage and rubbish handled in 1916 as compared with 1913; 3.35 per cent. smaller force in 1916 than in 1913; instituted system of instruction of men in standard practices; established model district, securing improved service at lessened cost; constructed three new, modern, covered, sprinkler-equipped dumps, minimizing dust and odors; instituted improved purchasing methods; negotiated new garbage contract that increases city's revenue $100,000 a year; reorganized clerical force and systems of accounting, and in many ways added to the contentment and welfare of the force.

Snow Removal Methods Revolutionized.

The major achievement of the department has been its revolutionizing of snow removal methods. The rate of removal has been more than trebled, while the cost per cubic yard removed has been reduced 68 per cent. At the average cost per cubic yard of the four preceding winters, snow removed in the last two winters would have cost $5,394,159 more than was actually expended on that account. Many thorofares formerly entirely neglected have been cleared during the past two winters and are now scheduled for snow removal. The old custom was to wait until a snow storm had ceased before beginning snow removal. The new custom, inaugurated by the present administration, under J. T. Fetherston, commissioner, is to begin removal while the snow is still falling. Mr. Fetherston's latest annual report, released June 7, 1917, gives this information on snow fighting methods and results.

Considered from the viewpoint of the public and measured by the effect upon business interests and the personal convenience of citizens, it is probable that the changes in methods of snow removal represent the most noticeable feature of this administration's progress. The time-honored system of removal by contractors has been amended to the extent that the city now does the larger part of the work, by the direct employment of labor and the use of department equipment. Owing to contracts in existence when the present administration assumed direction, application of the new principles was confined in the winter of 1913-1914 to a limited use of sewers for snow removal.

As a result of the winter's experience and tests that were made, it became apparent that the city had had available for years a possible solution of the problem of rapid snow removal, thru the extensive use of sewers, not alone after a snowfall, but during the progress of the storm. The experience of that winter demonstrated to the satisfaction of this administration that snow work should be started with the storm and clean snow dumped into the sewers as it falls. Such methods imply an attempt to keep pace with a storm,

CLEANING SNOW FROM NEW YORK STREETS.

PANNING SNOW INTO SEWERS.
PLOWING THE ACCUMULATION TO STREET CENTER.

HOW FLATCARS AIDED IN RAPID DISPOSAL.
KEEPING STREETS OPEN VIA MOTOR SNOW PLOW.

instead of trying to dig the city out after a blocking of traffic has occurred.

Systematic Preparation for War on Snow.

In the summer and fall of 1914, the department made preparations to apply during the following season its new program for handling snow. This preparation included a thoro survey of the city's sewer system, specialized instruction of the department's forces, enlargement of standard equipment, enrollment of emergency workers as "snow fighters" and the platting of the city so that practically 50 per cent. of its entire area could be cared for by the simultaneous attacks of the "snow fighting" gangs, within four hours after the call to go to work. Plans called for pushing snow into sewer manholes by the use of pan-scrapers operated by hand, and drag-scrapers, each drawn by a single horse.

These plans did not eliminate contract snow removal, as large quantities of snow still had to be carted to the river dumps or main sewers; nor did they release the city railways from their obligations to clear the snow from certain streets carrying railway tracks. But up to this time the city had depended upon trucks alone to haul snow from the streets to water front dumps and, consequently, the speed of snow removal had depended upon the supply of trucks available for the work.

New Methods of Snow Fighting Successful.

Results of the application of the new system during the winter of 1914-1915, as compared with preceding winters, showed that the rate of removal doubled as compared with the best previous record, and that the cost per cubic yard decreased 67 per cent. compared with lowest previous unit cost record. The total fall of snow for the winter was 22.4 inches, and the total cost of removal was $523,892. If the entire snowfall of the winter had been handled by contractors' trucking forces alone, at the lowest previous contract rate ($0.367 per cubic yard), the cost of the season's work would have amounted to $1,584,822. The total area of the streets in the three boros scheduled for snow work in the winter of 1914-1915 was 32,607,081 square yards, or 927 miles of streets.

Snow Plows Meet an Emergency.

When the first snow of the winter of 1915-1916 arrived, it found the department further strengthened by valuable additions to its equipment and better trained organization; but the beneficial effects in these improvements were counteracted, to some extent, by the shortage of labor available for emergency snow work. Schedules called for 14,737 emergency laborers, working in nine-hour shifts, while storms were in progress. The average number of men secured was 9,060, or 61 per cent. of the required number. Use of snow plows, designed by the department and attached to commercial motor-driven trucks, aided in reducing the effect of the shortage of labor. These plows were used for piling snow in the center or on the sides of streets.

Over 50 inches of snow fell during the winter, compared with the average fall of 32.2 inches. The total area scheduled for snow work in the three boros had increased to 33,311,899 square yards, which represented 946.17 miles of streets. Nearly 12,000,000 cubic yards of snow (truck capacity basis) were removed at a gross cost of $2,521,299.55, or at the rate of 21.2 cents per cubic yard. This was more than double the quantity (truck capacity basis) removed by the city during any previous winter season, and the cost was less than half the average cost per cubic yard for the previous seven years. No serious complaints were made regarding snow removal during the season, which is creditable to speedy action in opening main arteries with automobile snow plows, employment of the largest procurable force of emergency laborers during storms and the use of sewers for the disposal of snow.

Highest Rate of Snow Removal.

Including the statistics of the snow storm of last December the total fall of snow for the calendar year 1916 was 54.6 inches, averaging for the previous forty-seven years 32.16 inches. The daily rate of removal during 1916 was 198,000 cubic yards, compared with the grand average, 1907 to 1915, inclusive, of 71,886 cubic yards. Rate of daily removal during and following the storm of December 15 last surpassed all previous records. There was a snowfall of 12 inches. The cubic yards removed totaled 2,178,301. Nine days were required for completion of the task, the daily removal approximating 242,000 cubic yards. This record was achieved despite a shortage of labor, because of the almost perfect working of the system established by the department. An important feature was the use of 120 city snow plows driven by commercial motor trucks.

Snow Fighters Registered.

There were on the registration lists of emergency workers or "snow fighters," at the begining of 1916 a total of 13,426 names. During the storms of February and March an approximate average of 60 per cent. of the total number registered were actually secured for the work. During November and December, 1916, the registration of emergency workers was 9,082; approximately 45 per cent. of those registered reported for work on the storm of December 15, during which 12 inches of snow fell. The total snowfall for 1916 was 52 inches. The total area of streets from which snow was removed was 24,459,686 square yards, and the length of the streets 695 miles. Some snow was removed by contract in 1916. This covered 5,748,460 square yards of street area and 163 miles of streets.

An inventory of the machines and tools assigned to snow removal work, on the last day of 1916, gave: 169 auto plows, 83 horse-drawn plows, 4 sand spreading machines, 100 bags with auto plow parts (carried on auto trucks for making minor repairs to auto plows in the field), 20 boxes with auto plow parts (in stables), 19 boxes with auto plow repair tools, 13,264 pan-scrapers, 7,524 shovels, 7,436 picks, 885 bleeding poles, 22,321 red flags, 194 flashlights, 335 hydrant pumps, 1,140 hydrant keys, 411 nozzles, 255 reducers and 945 hose lengths.

The average daily rate of removal for the two years, 1911-1913, under the old method was 51,390 cubic yards at an average cost to the city of $1,535 per cubic yard. Under the new method, 1914-1916, the average daily rate of removal for the two years was 234,211 cubic yards, at an average cost of $0.188 per yard.

Had the old methods and contract prices prevailed during the winters of 1914-1915 and 1915-1916, the total cost of snow work would have been $8,682,792.66 instead of $3,045,191, or a difference of $5,637,601.66 in favor of the new methods.

Methods of Increasing Efficiency of Entire Force.

Scrutiny of the methods of performing the important functions of the department, in force when Mr. Fetherston took charge, disclosed a condition, in which there was an almost entire absence of system. Each district had been permitted to devise its own way of doing the work; there were almost as many different ways of doing the same things as there were working districts in the city. Apparently, the department had been conducted upon a theory that any one who had the physical strength to manipulate a broom or lift a can filled with refuse matter was qualified as a sweeper or driver.

Inspired by the conviction that the quality of the service rendered by the individual employe would be greatly improved if each was carefully instructed and trained in the work assigned to him, a campaign of education was determined upon. It was decided that the first step in carrying out this plan should necessarily be a thoro inquiry into the methods employed theretofore, with a view to the elimination of

the inefficient and wasteful; this to be followed by the strengthening and standardization of the efficient.

In undertaking this work the head of the department took counsel from every available source, having the support of scientific knowledge of the problems to be dealt with and from those whose practical experience made valuable their suggestions and opinions. The matured thought of the engineer was then brought into contact with the actual experience of men who had gained their knowledge and formed their opinions in the field of the department's operations.

Standard Methods Adopted.

Field officers, some of whom had been in the service twenty or more years, were called into conference with the head of the department and his engineers, and a thoro analysis of past methods of this city and elsewhere (as far as possible), together with new and advanced thought, was had. The tangible result of these conferences was the adoption of standard methods for the performance of the several branches of the work. A series of booklets, clearly setting forth in detail the approved method to be employed in the performance of each phase of the work, was printed, and each responsible officer of the department was supplied with a complete set of the booklets, with instructions to observe strictly the rules laid down.

The result of this procedure was to fix uniform methods thruout the territory under the jurisdiction of the department. All districts are now striving to reach the common plane of performing the same work in the same way, giving the service the benefit of the best methods of each district, fortified by new and approved features, and discarding the inefficient and time-wasting.

To secure the best results of this standardization, it was apparent that not only should the officers be instructed and drilled, but that the men under them should be trained. Right there was found the most difficult factor in developing the new system. Sweepers, drivers and other workers who have become accustomed to generally following their several respective ways of doing things—frequently starting wrong and never getting right—have much to unlearn before they become amenable to new teaching. "It's difficult to teach an old dog new tricks." While it is the policy of the administration to insist that the officers require observance of the methods set forth in the books of rules, it is understood that there are habit-formed obstructions to adaptability.

A School of Instruction.

To assist in solving this difficulty and to provide for its gradual removal, a school of instruction was established, in which all recruits are given a practical education in their duties and in the methods of performing work. Men who have passed the civil service examination and have been recommended for the sweeping, driving or other uniformed division of the force, are given courses of instruction in the school before being assigned to regular positions. Competent instructors are in charge of the classes and using the above mentioned books of rules as text books, and in simplified manner making perfectly plain every detail of approved methods of performing the work, they instill into the minds of the beginners correct principles and train their hands to the most efficient application of these principles. The school also inculcates in the minds of new city employes their responsibility as temporary custodians of city property in the form of tools and machines, and impresses upon them their obligation properly to conserve such property.

During the seven months that the school of instruction has been in existence it has trained and turned out for active service, 183 sweepers, 148 drivers, 30 chauffeurs (20 of whom are tractor drivers) and one craneman. Special courses of instruction have also been given to 340 officers of the department during the same period.

It is believed that because of the training given the men who are newly recruited for the service, there will be a constant and perceptible improvement in the quality of the work performed by the individual worker. This in conjunction with an established system for the whole department and officers trained so uniformly direct the work along lines of greatest efficiency will inevitably produce results gratifying to the public and the department.

THAWING WATER PIPE TRENCH

A practical and economical method of thawing out a trench for the relaying of a frozen water main was worked out by Edgar S. Smith, Superintendent of the Water Department of Pocatello, Idaho, and is described by him as follows:

The city of Pocatello, Idaho, has experienced the longest siege of cold weather during the past winter ever recorded there, with the result that thirteen blocks of 4-inch cast iron mains were frozen with an 80 per cent. loss of pipe. As the frozen main had to be lowered soon on account of proposed street improvement work, they decided to dig up the old line and lower a new one to grade. To offset the cost of trenching in frozen ground was the cost of some kind of temporary relief demanded by the people immediately, the probable scarcity of labor and increased wages, and the loss of revenue for several months.

The thawing of the ground and removal of the old pipe which was 3½ feet deep was accomplished in 17 days. A double line of 1½-inch pipe was laid over the site of the trench and covered to a depth of 6 inches with fine sand. Steam was supplied from a traction engine. The first day a stretch of 180 feet of pipe was laid, but it was found that hot water and steam were returned to the boiler, which showed that we were not using all the heat generated. A little experimenting showed that we could handle a 300-foot stretch at a time. In the morning the shovel gang would throw the sand off the pipe in about 10 minutes and the traction engine would pull the pipe to the next block. Two teams and two men would move the sand and have the pipe covered again by 10 o'clock and the steam would be kept in the pipe until the next morning.

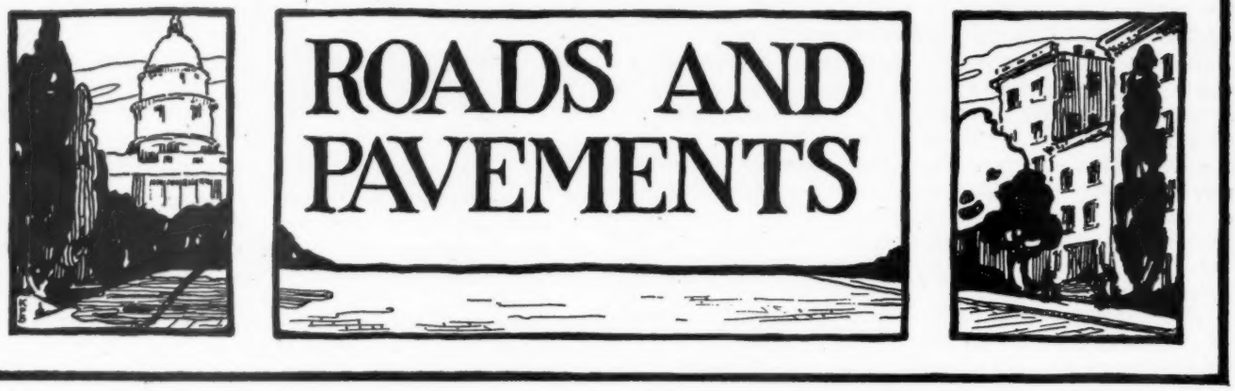
The ground was frozen to a depth of 4½ feet. After applying the heat for 24 hours the ground was clear of all frost for a depth of 2½ feet and very easy to excavate. Below that the frost was so soft that the ground was easily loosened with a pick. The added expense for trenching under such conditions was as follows:

Rent of traction engine per day	$ 3.00
Engineer on day time	5.00
Fireman on during the night	4.50
One ton of coal	8.00
Teams four hours	3.00
Labor four hours	1.50
Twenty laborers 15 minutes	1.85
Sand, and hauling water to boiler	1.50
Total	$20.35

Length of trench opened, 300 feet.

Cost per foot, $0.094.

As soon as the new pipe was laid it was covered with manure, the excavated material having frozen solid, and as fast as the services were connected to the new main they were thawed out by electricity.



Motor Trucks in Public Service

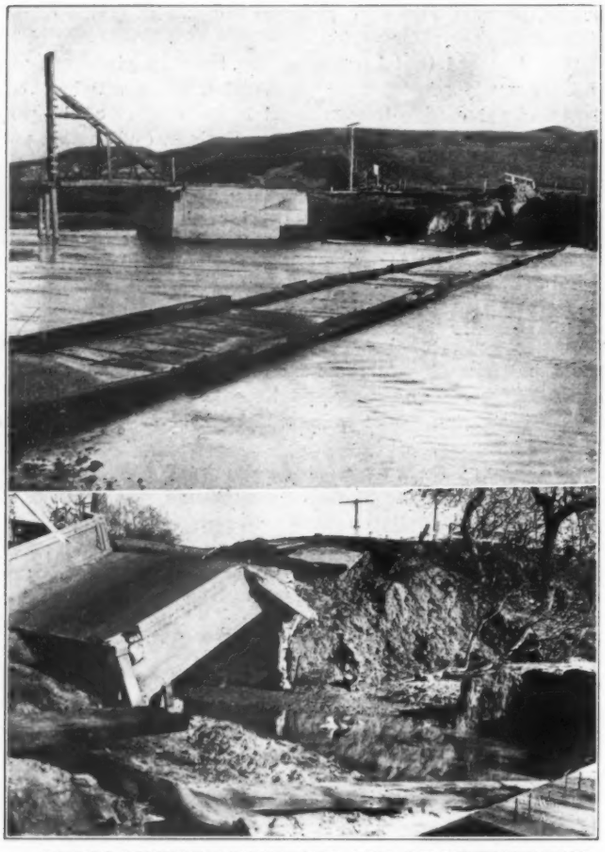
In the reconstruction and emergency work on the good roads system of California during each rainy season the motor truck has proven an important factor. The work accomplished by the California Highway Commission in first-aid work in bridging of swollen streams has opened a new avenue of usefulness for the commercial car.

A fleet of trucks in use by the California Highway Commission has proved that a loaded truck can be sent across pontoon bridges or temporary structures that can be built across streams in a few hours in case the bridge is washed out. In a recent storm the majority of bridges between San Juan Capistrano and Oceanside were carried away by the storm. In this interlying district building material was absolutely unobtainable, as even the railroads were cut off.

Over the deepest washouts temporary bridges were constructed, in many places the truck being driven thru mud hub deep, over ditches and along the bed of a river, distributing material along the route. Large crews of men were worked at different washouts, and they were supplied by the trucks.

Not alone has the truck simplified emergency road construction, but it has reduced cost to a minimum. In the day of the horse-drawn vehicle nearly half of the men's time was spent in going to and from camp. The truck has eliminated these expensive delays, as it also has removed the necessity of many costly camp moves.

CALIFORNIA HIGHWAY COMMISSION'S ROAD-REPAIR GANG WITH MOTOR TRUCK CONSTRUCTING TEMPORARY BRIDGE OVER WASH-OUT IN A STATE ROAD.



TYPES OF WORK REQUIRED AND OF DIFFICULTIES TO BE OVERCOME BY REPAIR GANG AND TRUCK.

ABOVE: PLANKED CROSSING FOR USE UNTIL NEW BRIDGE IS BUILT. NOTE APPROACH TO PLANK ROADWAY ON RIGHT.

BELOW: CONCRETE BRIDGE RUINED BY FLOOD. SOME WORK REQUIRED TO AFFORD TEMPORARY PASSAGE.

Pasadena placed in operation some time ago the first truck of its kind in the world. This car is an aid to the street department and is eliciting high praise from the Pasadena officials who have carefully watched its operation. It does the work of a two-horse and a one-horse outfit. The driver and helper cover 48 miles of street daily, removing every particle of rubbish and sweepings. The refuse is taken to the city parks to be placed in compost heaps and used as fertilizer. At the usual rates paid by orchardists this rubbish would be worth at least 3½ cents a square foot or more than half the cost of collection. The truck is built on a 1½-ton chassis and the body is especially made, being very unique in appearance. It is 9 feet long and 2 feet deep with additional sides 18 inches wide flaring at 45 deg. angle. The truck carries 6 to 8 yards of material at every trip and makes three trips a day.

Rated capacity is 165 cubic feet. The tail board is movable as is the interior, and it is of dump type. The chief inspector of Pasadena street department says that the truck is an entire success as a money-saving device.

The city of Los Angeles is the proud possessor of one of the finest garages in the United States. It has been installed for the single purpose of taking care of the automobiles, trucks, motorcycles and engines in city use. Every city machine wanders into this plant at least once or twice a year and gets a complete overhauling.

This garage started on a rather small scale, but rapidly increased as more and more cars were added to the city service. At the present time sixty mechanics are kept busy all the time and hundreds of pieces of apparatus pass thru the shops every year.

The equipment is first class in every respect and is so complete that any kind of work can be done. Fire engines are completely rebuilt from boilers down. Automobiles are reconstructed from the ground up. The speed motorcycles of the city officers are continually on deck, getting small troubles fixed and trying to be patched up after accidents of more or less seriousness.

There are about 180 pieces of apparatus in city use. This includes fire engines, police machines, ambulances, trucks and motorcycles. All of these machines are repaired in the city garage. The several departments represented in the list are fire, police, health, hospital, park, engineering, humane and municipal market.

Efficient Haulage With "Road Train"

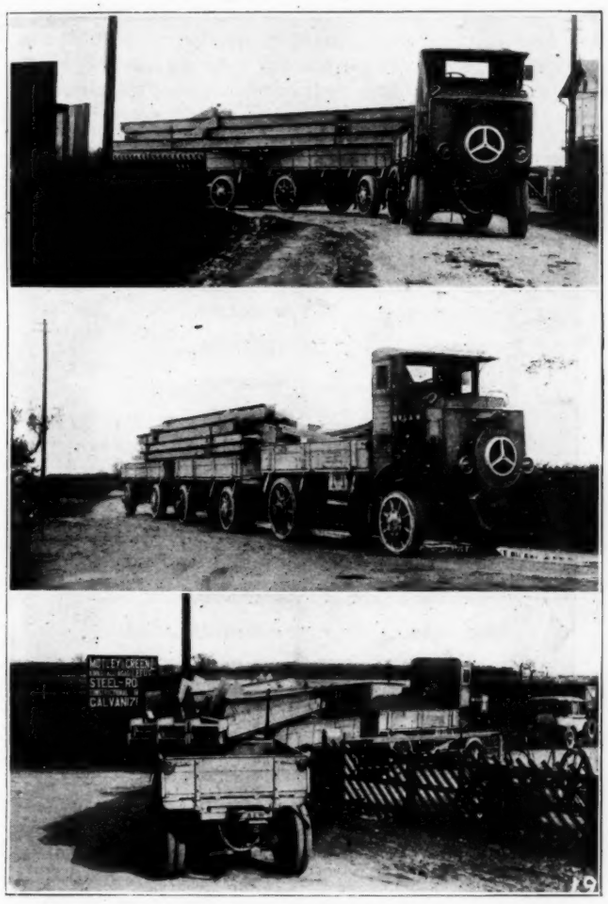
One of the most recent developments along the lines of low-cost haulage is the Armstrong-Whitworth road train as now used to a considerable extent in France and England. While this train has all of the valuable features of the older style train, which consisted of a tractor or truck pulling a train of loaded wagons, it also has merits which could not possibly be attained with the use of a single pulling unit. Chief among these is the ability of the Armstrong-Whitworth train to go backward as easily as forward, taking corners in the track of the leading truck. As traction is furnished to the wheels of each one of the trailers, the effective pull and adhesion to the roadbed is much greater than could be expected where all of the tractive effort came from the two or even four wheels of one truck or tractor.

While several mechanical and electrical trains have been devised from time to time, none of these have been entirely free from faults which prevented, or at least impaired, their success. A number of the purely mechanical trains depended on a more or less complicated arrangement of driving shafts and universal joints, which carried the engine power from the truck, applying it to one after the other of the trailers. Because of the multiplication of bearings, spring drives and transmission, and also because of starting and braking difficulties, this variety was doomed to an early failure.

In a general way, the "all electrical" trains were an improvement, yet left much to be desired. Fundamental in this scheme was the use of a powerful engine-driven dynamo, which supplied current to motors not only in all of the trailers, but in the tractor as well. While the starting difficulties were overcome, and there would naturally be a wide latitude in the matter of speeds, the apparatus was somewhat cumbersome, and due to unavoidable electrical losses was not highly economical.

With the combination of the electrical and mechanical systems in the Armstrong-Whitworth train, the difficulties inherent in both "unmixed" drives seem to have been eliminated. Power is supplied direct to the tractor by the gas engine. A dynamo of moderate size generates power for all of the trailers, each of which is motor-equipped. On starting, when a heavy pull is demanded, electric power is transmitted all along the train, and each trailer does its part in supplying tractive pull to set the train in motion. As the trucks come up to their normal speed the auxiliary motors are cut out, and what work is necessary to keep the loads moving at ordinary speed is taken care of by the engine alone. Where heavy grades or rough roads are encountered, the trailer motors can instantly be set to work by the driver.

As a result of the efficiency obtained by the elimination of many of the electrical and mechanical losses, it is claimed that remarkable fuel economy is obtained by the Armstrong-Whitworth train. Tests conducted with a 30-ton load showed that 77 ton-miles were made to each gallon of gasoline. This was on a non-stop run of 210 miles, over wet roads.



GAS-ELECTRIC ROAD TRAIN TURNING CORNER WITH 27½-TON LOAD OF GIRDERS.

ROAD TRAIN ON THE "STRAIGHT-AWAY" WITH 30-TON LOAD; 5 TONS ON TRACTOR AND 25 TONS ON TRAILERS.

LOADED ROAD TRAIN BACKING AROUND SHARP CORNER.

A feature which is of considerable importance and which could hardly be obtained in any train other than an electrical one, is that which permits operation of a trailer separate from the tractor. By the simple expedient of attaching a long transmission cable to carry current from the truck generator to the trailer motor, the trailer (controlled by a driver) can be operated over a range of several hundred feet quite independent of the movement of the tractor itself. This allows a train to be taken in sections over a weak bridge or thru a very bad stretch of road where handling the entire train would be a difficult matter.

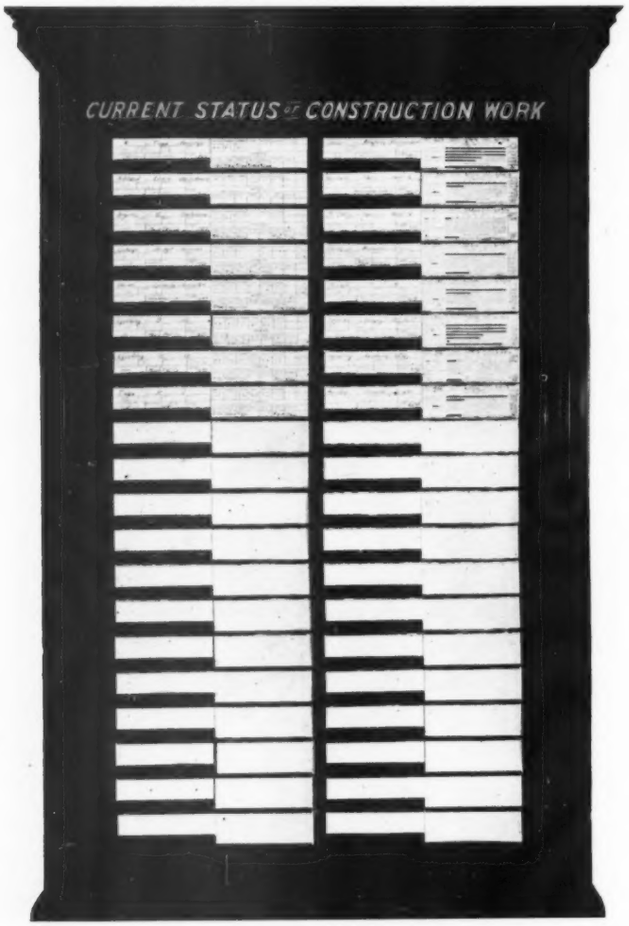
Electric lighting and electric brakes are features of the new train. The tractor motor is self-starting.

Planning Board for City Work

In order that the chief engineer and his assistants and subordinates may at all times be informed on every phase of construction work, either contemplated or in progress, the Philadelphia Bureau of Highways makes use of an unusually complete planning board. As applied to the Philadelphia highway problems, this board eliminates almost entirely the necessity for constant reference to office records, and presents all facts graphically in such a way that they are instantly and easily grasped.

As worked out by Mr. Wm. H. Connell, chief of the bureau, the system includes not only the boards, but current status records, indicators and daily progress reports. Of the current status record two forms are used, one for contract work and one for municipal work. This is for the chief engineer. Another form in three parts is used by the district assistant engineer. These forms give all necessary facts regarding the current status of work authorized, under contract and under way.

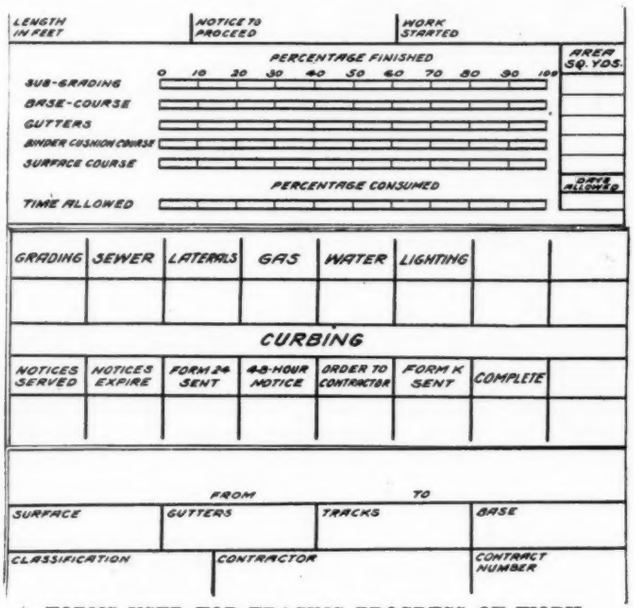
The planning board itself consists of a framed map showing the district involved. For the chief engineer this field is the entire city, while for each assistant only the portion over which he has direct charge is included. In each case the scale is sufficiently large to show all details plainly. For the chief engineer and the division engineers, a scale of 1,000 feet to the inch has been adopted, while for the assistant division engineers the more detailed proportion of 500 feet to the inch is selected. This gives the assistant division engineers a record of all work down to the most minute detail.



PHILADELPHIA'S PLANNING BOARD.

Colors applied to and shown on these maps indicate the kind of pavement. If more than one material is used on a street, the fact is indicated by the proper tints. Maintenance guarantees covering certain sections of paving are indicated by a penciled cross-hatching which readily can be erased on expiration of the guarantee period. Plain blank tints are used to indicate the existence of street railway lines.

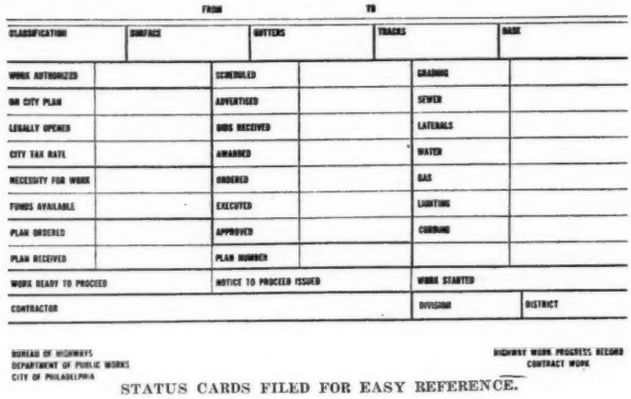
For recording permanent information, a series of specially colored and labeled flat-headed tacks are used. These tacks



FORMS USED FOR TRACING PROGRESS OF WORK.

by their appearance tell the observer at a glance some vital fact about conditions at the various points where they are inserted. Further reference is given by numbers imprinted on the tack heads, these numbers referring to numbered cards, on which is detailed all information about the point in question. Information of temporary value is given by colored glass-headed pins of varying sizes.

In order to fix responsibility for the proper "posting" of information, each board is supervised by a single employe, whose duty it is to see that all changes are made promptly and that the information recorded is at all times accurate. This posting is done at the beginning of each working day from reports turned in by inspectors and engineers.



STATUS CARDS FILED FOR EASY REFERENCE.

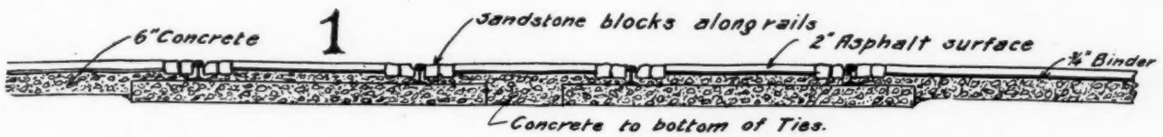
Daily data on each job is sent in to division engineers. This is in addition to the detailed construction report that goes to the district assistant engineers. These "progress reports," as the daily postcard reports are called, indicate detailed facts as to the force employed, weather conditions, temperature and other necessary facts. These cards are then filed in alphabetical order in the division engineer's office.

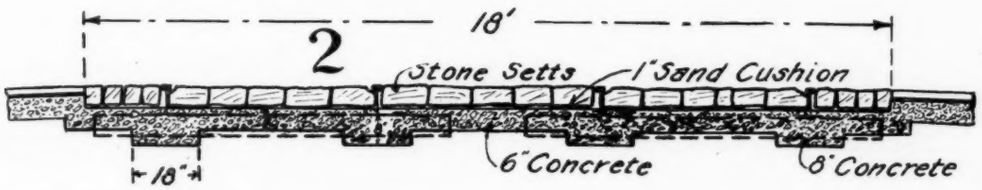
Paving Street Railway Tracks

There is probably no other public utility which has undergone a greater evolution in the last twenty years than the street railway. During the last few years of development the cars that were used averaged about five tons in weight, and the pavement in the track areas was designed accordingly.

In the past few years the development has been extremely rapid and the weight of the cars has jumped from ten tons to the double-trolley twenty-five-ton cars which are today used in Ottawa.

Fig. 2 shows the next style of pavement tried in the track area. It will be noticed an extra body of concrete was placed under the rail 18 inches in width by 18 inches in depth (from the web of the rail). This type was discarded in 1912 owing to several weaknesses which developed within two years of the pavements being constructed. The principal weakness developed in the two outside blocks next to the asphalt and also for about 12 inches on the asphalt next the blocks. Fig. 3 shows how the pavement deteriorated. It will be observed that the two margin blocks began to sink an appreciable distance below the rail, the asphalt following suit. This was due





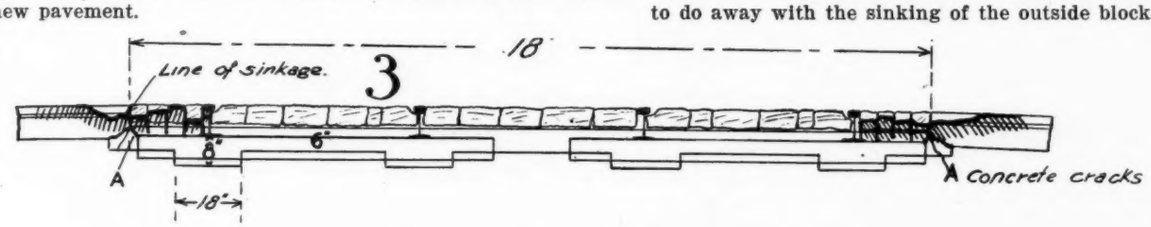
The writer intends to give in this article details of the various kinds of pavements constructed in Ottawa on the street railway area, showing the evolution from the time the pavement was designed to stand the five-ton car.

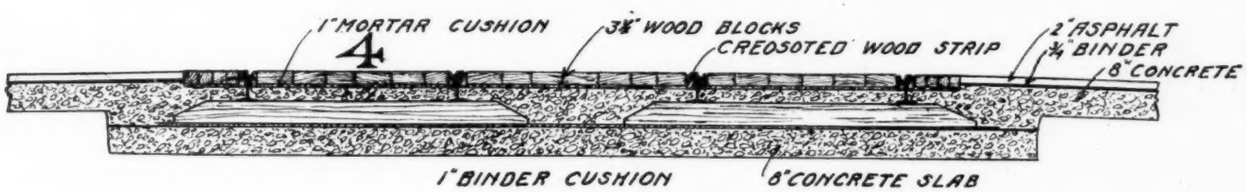
Fig. 1. shows the type of pavement which was first constructed in Ottawa in the tracks allowance; this was about twenty years ago, and happily only two streets were laid in this manner. Before these streets were repaved the whole track area had deteriorated due to the vibration of the heavy street cars. The two sandstone blocks that were laid in the manner next to the rails had sunk about six inches and the asphalt between the blocks was so badly cracked that passing vehicles striking the rails or blocks with their wheels lifted sheets of the asphalt. Before the debenture period had expired the city had spent enough money on repairs to construct a new pavement.

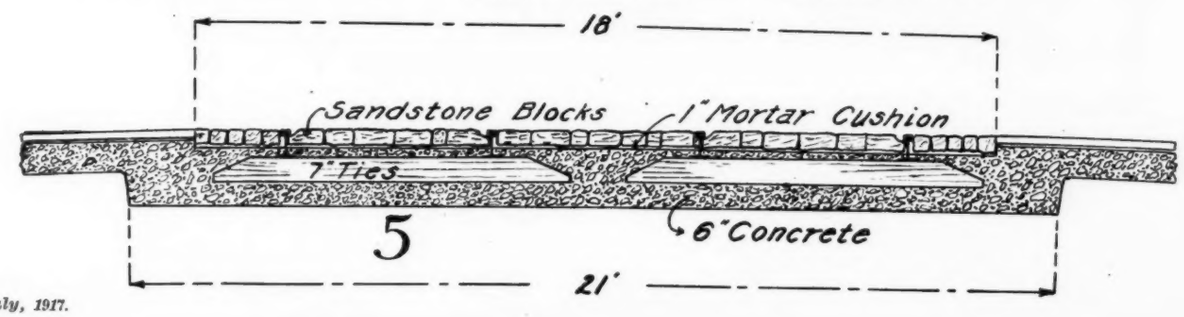
entirely to the foundation not being strong enough to support the heavy city and interurban cars. The vibration of these cars shook and cracked the concrete at the end of the wood ties as shown in Fig. 3 at the point marked "A." The vibration continued until the concrete crumbled away under the blocks, with the result as stated above.

In 1914 the type of construction for the track allowance was radically changed from former types. Bank street, one of the main business thorofares, was to be repaired and it was done as shown in Fig. 4. An 8-inch concrete slab was first laid 21 feet wide. On the top of this slab was laid a one-inch cushion of asphalt macadam for the ties to rest upon, (this cushion greatly reducing the noise of the cars).

The writer had the railway company bevel the ends of the ties as shown on the section. This was tried as an experiment to do away with the sinking of the outside blocks—a bad fea-







ture of former pavements as already explained. It will be seen that with the beveled ties a much heavier body of concrete is between the outside blocks and the ties, thereby preventing any chance cracking and crumbling of concrete by the vibration of passing cars. Wood blocks were used to pave this track allowance.

The practice of laying the concrete slab first has since been done away with, as we had trouble with the ties, in setting the rails to grade. These ties were supposed to be 6 inches in depth, but in reality ran between 6 and 7 inches, with the result that we had to place steel wedges under them when bringing the track to grade.

Fig. 5 shows the method of construction used in 1915 and 1916 on tracked streets where the traffic is fairly heavy. The concrete is shown as being one solid mass. The rails were suspended and the concrete poured, thus obviating the trouble we had in the case of Bank street. Sandstone blocks were used to pave the track area.

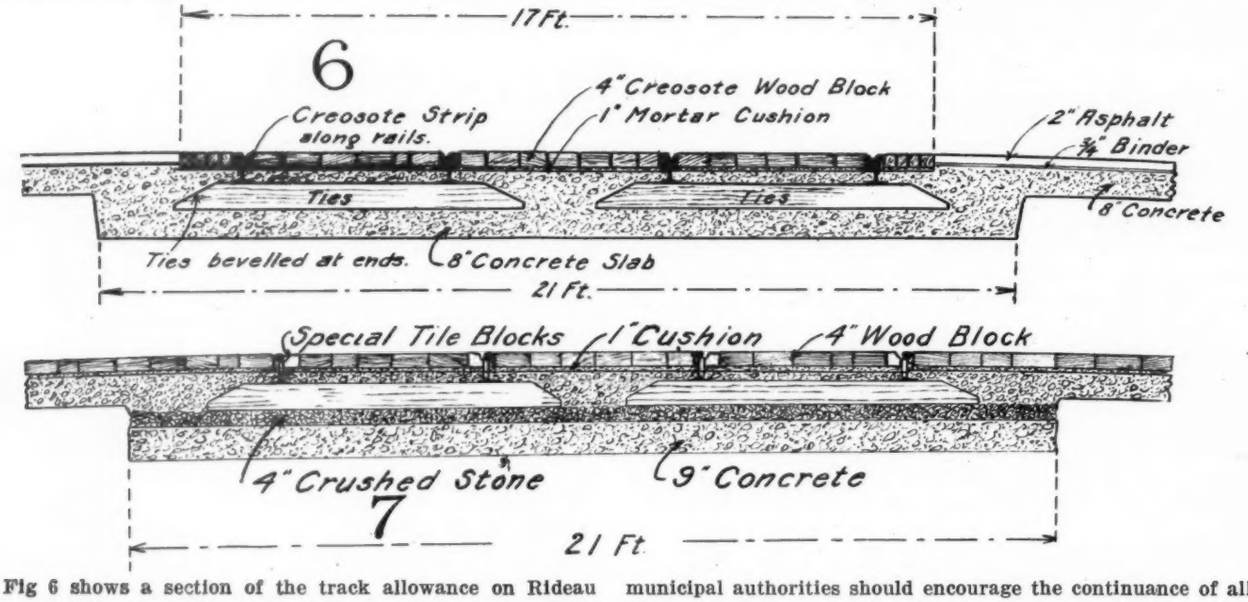


Fig 6 shows a section of the track allowance on Rideau street, which was constructed this year. This is practically the same construction as shown in Fig. 5, with the difference that the depth of concrete under ties was increased to 8 inches and wood blocks were used instead of sandstone. An extra block was added to the margin to bring them beyond the edge of the ties, doing away with any chance of vibration which would cause the asphalt to crack.

In the Rideau street pavement a change was made in the construction where the railway company's special work was laid. Instead of the rigid usual construction in straight track work, the concrete slab was laid first to a depth of 9 inches. On this was laid a 4-inch covering of 2-inch stone, upon which the ties were laid as shown in Fig. 7. This allows greater flexibility and also allows the special work to be renewed without disturbing the concrete slab. All pavement in the special-work area will be constructed in this manner in future.

Fond Du Lac's Trucks Save Money

A report submitted by Chief Dolly of Fond du Lac, Wis,, proves that a considerable saving resulted from the use of motor fire apparatus by that city in place of the horse-drawn trucks. Carefully compiled figures showed that the expense of operating the motor trucks thru a three-year period was $672.52 while the expense of a two-horse fire truck for the same period was $1,083.95.

Keep on Building.

At no period in our history have we been so sure of the future. The western world's stomach is feeling the pinch of hunger, and its demands on the products of America's broad acres and American industries are growing with every passing hour. A great market is opening wider and wider. Honest and fair profits in all lines of legitimate effort are certain.

There should be no curtailment in building and road construction. Let both public and private useful construction proceed. Production and handling of building materials and public and private construction work are fundamental industries of the country. Any tendency to suspend or postpone building projects is inconsistent with maintaining our prosperity. The country is prosperous. Building investors should not hesitate to go ahead with their plans. Railroads should spare no effort to supply the building industry with the cars needed to transport materials. Government, state, county and municipal authorities should encourage the continuance of all kinds of building. Road and street improvements in particular should go on unabated. Bad roads and streets are factors of first importance in the present high cost of foodstuffs. Never before was the improvement of highways so essential.

Will Make Wire-Cut Lug Brick.

The Brick, Terra Cotta and Tile Company, of Corning, N. Y., Mr. M. E. Gregory, proprietor, has become a licensee of the Dunn Wire-Cut Lug Brick Company, of Conneaut, Ohio, and will engage in the manufacture of wire-cut lug paving brick. This company is one of the most important paving brick concerns in that section of the country, and it is widely known for the quality of its product and the reliability of its business methods. Mr. Gregory, the proprietor, is one of the leading business men of that section.

Higgins Road Contract

Contract for the Higgins Road, commencing at a point six miles from Chicago's city limits, and ending at the county line, a distance of 18½ miles, has been awarded to the Commonwealth Improvement Company, of Chicago. They have placed a sub-contract for a narrow-gage railway for handling of the aggregate, with the Orenstein-Arthur Koppel Company, of Chicago. This railroad consists of 8½ miles of Koppel portable track, the necessary Koppel dump cars, etc.

Novel Sewer-Cleaning Device

The accompanying illustrations show a recently perfected machine designed for sewer cleaning from the street surface and eliminating many of the disagreeable features of old-fashioned interior work.

The device consists of two 4-wheeled trucks placed at two successive manhole openings and a special steel bucket which is pulled between the manholes by means of a cable. One end of the cable is attached to a hand-winch on one truck, and the other end to a similar winch on the other. The bucket is not necessarily drawn from one manhole to the next, but is drawn into the sewer only far enough to be filled with the deposit and then pulled out of the same manhole in which it was inserted.

This is made possible by the peculiar construction of the bucket, which has two hinged scoops at one end so arranged as to close up tightly as soon as the reverse pull is made, and also to expand the bucket as it is emptied. Four guard-plates are riveted to the sides of the bucket to prevent excessive wear and they constitute a hinge for the jaws. The edges of the scoop are finely sharpened to cut any roots or growths that may be located in the sewer bottom.

One noteworthy feature of the apparatus is the means whereby the full bucket is lifted out of the manhole without the cable cutting into the sewer or manhole brickwork. This is effected by a guide-jack, consisting of a yoke with ball-joint adjusting screws at one end, and a wedge connection on the other end. This is lowered into the manhole on chains hooked to the manhole-rim, and carries a pivoted arm with a cable pulley. When the bucket is being taken out, it strikes the arm, revolving it upward about its pivot, so that the bucket is guided free out of the sewer-tile and then up the center of the manhole without obstruction.

The sharpened jaws scrape the tile thoroly, so that every particle of debris is removed. When shut, they are so tight that nothing in the bucket can escape.

TROLLEY-JACK AS USED IN PULLING EXPANSION BUCKET THRU SEWER. WHEN THE REVERSE PULL IS MADE ON THE CABLE THE JAWS OF THE BUCKET CLOSE AUTOMATICALLY SO THAT NOTHING CAN ESCAPE EXCEPT THE EXCESS WATER, FOR WHICH SPACE IS PROVIDED ALONG THE SIDES OF THE BUCKET.

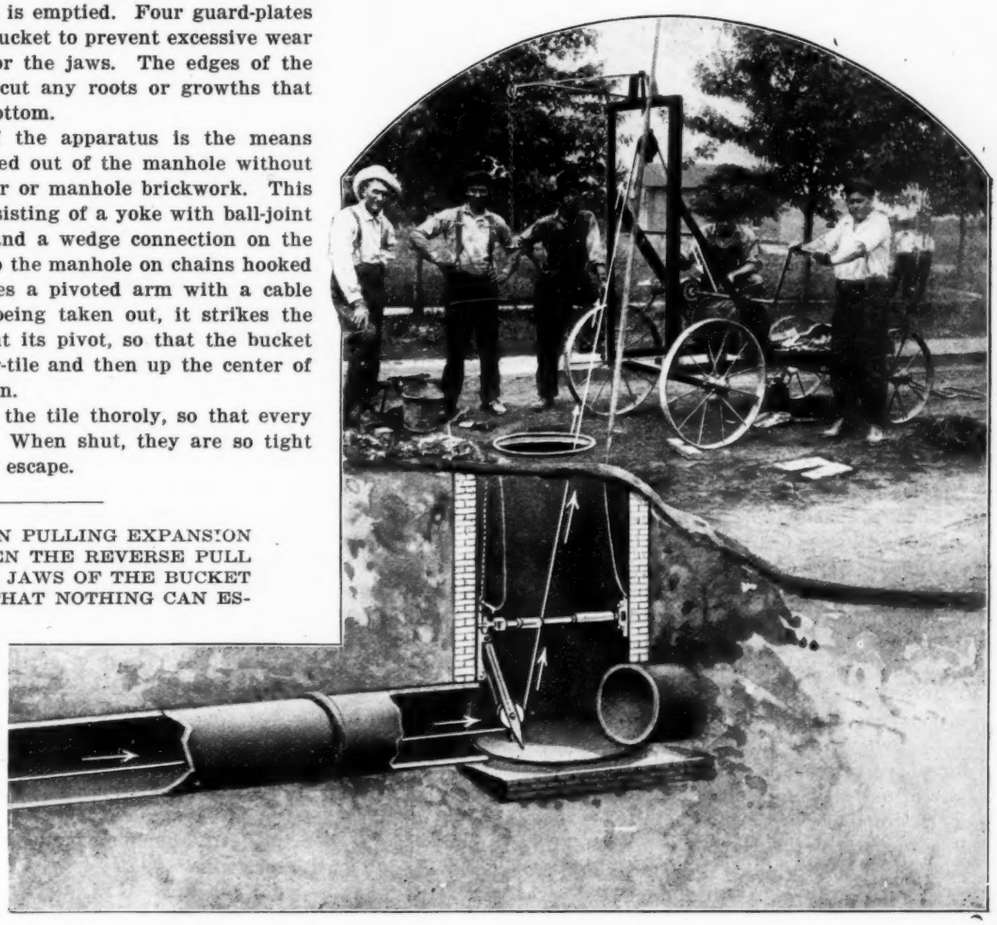
Courtesy of "Popular Mechanics."

Low Cost Water Main Cleaning

Very little skilled labor is needed for the work of cleaning water mains when a recently perfected flexible-joint cleaner is put on the job. Aside from the superintendent and the foreman in charge of the work, the only highly paid man required is a single calker. In connection with work as done at Hartford, Conn., fourteen laborers were kept busy, one team also being required to haul material and supplies.

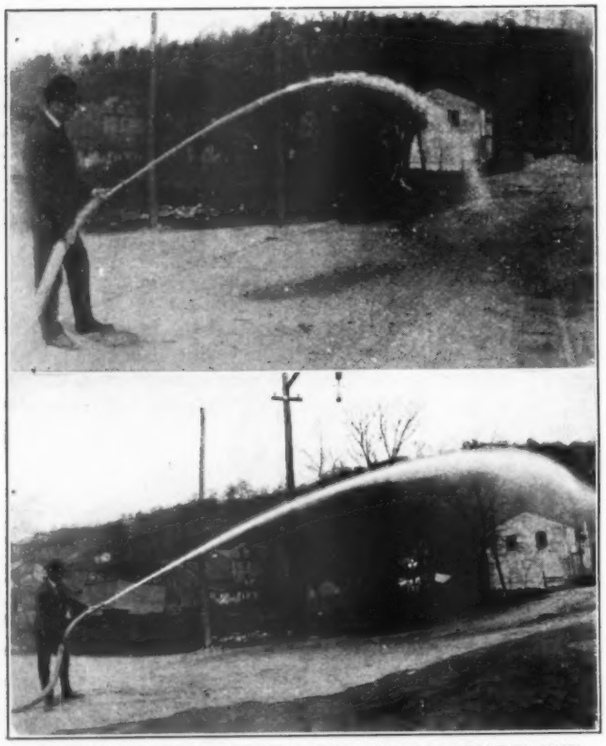
The machine itself is made up of three distinct sections held together by a central flexible-joint shaft. This joint arrangement allows the machine to pass around any curve of moderately long radius. Cutting is done by the first section which is made up of three spiders fastened to the shaft, all these spiders being provided with saw tooth blades. Even the hardest incrustations and scale are torn loose by these blades.

In the second section there are two spiders both armed



with smooth scrapers. Whatever material is left after the passage of the sawtooth scrapers is taken off by these smooth blades.

Both of these sections are propelled thru the pipe by the force of the water back of the cleaner. The water in the pipe presses directly on a double piston which fits very closely into the pipe. Leather gaskets pressed outward against the pipe make the piston practically water-tight. Dampers set into the piston allow sufficient water to pass the device to wash away the scale and slime that is detached from the pipe. Metal deflectors set loosely on the shaft serve to turn the flow of water against the pipe walls and keep the loosened materials well ahead of the cleaner. A double row of scrapers follows after the machine, these scrapers barely touching the pipe surface and taking any residue off so that a clean, smooth pipe is assured.



VIEWS SHOWING STREAMS THROWN BEFORE AND AFTER CLEANING OF WATER MAIN.

Thru the use of this piece of apparatus a large number of pipes that have become inefficient thru the accumulation of sediment have been restored to the same high efficiency level that they possessed when first installed. In some cities pipe systems that had not been cleaned for twenty-five years, and had lost a considerable percentage of their carrying capacity thru the deposit of slime and scale and thru growth of various organisms, were entirely restored.

As an instance of "before and after" efficiency, a test made in Brooklyn, N. Y., may be cited. Flow measurements were taken on 950 feet of 12-inch pipe which discharged thru an open end on the street. Before cleaning, this pipe carried 1,235 gallons per minute. After cleaning, with all other conditions the same as in the former measurement, the flow was 3,754 gallons per minute. These figures showed an actual discharge increase of 204 per cent. In addition the frictional loss of 98 feet before cleaning fell to 69 feet afterwards, with much greater flow. Taking both items into account, the carrying capacity of the pipe was increased by cleaning some 265 per cent.

A test made on a 6-inch pipe at Perth Amboy, N. J., in which the iron rust incrustation was exceedingly light (⅛ inch to ¼ inch) showed after cleaning an increase in discharge of 32 per cent. and an increase of 51 per cent. in carrying capacity.

To cite another instance: At Belle Plain, Iowa, there was a frictional loss of 39.8 feet per 1,000 feet of pipe before the cleaning was done. Afterward this fell to 9.7 feet per 1,000 feet. In another case a gain of 135 per cent. was shown.

Water mains at Mt. Vernon, Ill., became so dirty at one time that a full 60-pound pressure had to be maintained at the pumping station to show the required 20 pounds at the city office during the heavy draught hours. In addition to this difficulty the fire streams were very poor; water was muddy, and the cost of pumping was far too high. With clean pipes from which the slime and scale had been taken by the device illustrated, the average pressure at the pumping station was cut down by 20 pounds, and even with that decrease a higher pressure than before was maintained in the mains. A reduction of 27.7 per cent. was made in the power required to operate the pumps.

Electric Pumping in Michigan

Difficult problems which arise in connection with deep-well pumping of water for municipal use have been successfully overcome in the electric pumping system operated by the village of Richmond, Mich. These obstacles in the way of an adequate water supply are well recognized and are a direct result of the inability which frequently exists of locating wells near enough together to permit the efficient operation of steam pumps from one boiler. It has often happened that six or eight deep wells have been sunk before an adequate water supply has been obtained, the expenditure being followed by a discovery that the wells were too widely separated to be efficiently operated.

Under the head of "Deep Wells," as commonly used, fall all wells in which the water does not rise to the suction level. To these in general electric power can be applied with great economy. Two methods of deep well pumping are in common use, these being by the plunger lift principle and by the application of compressed air. The former principle is applied in the case of the plant described.

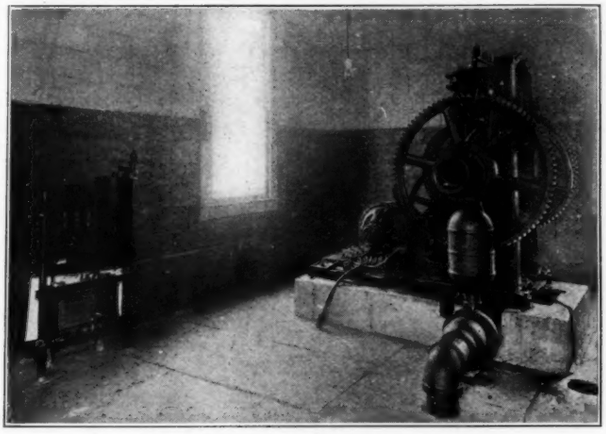
Water for the village of Richmond is obtained from three deep wells, two of which have 12-inch and the third 8-inch casing. All three are 131 feet in depth, and are ordinarily filled to within about 95 feet of the surface of the earth when the pumps are in operation. This water level is higher by about 30 feet when all pumps are stopped for a period. The three wells are located about 100 feet from the water works plant, and are so near together that they were for a time operated by standard steam deep-well heads. These were American Well Works vertical pumping heads, single acting, with a capacity of 200 g.p.m.

As a beginning of the change from steam to electrical operation a motor-driven head was installed for the steam head on one of the 12-inch wells, the pumping speed being increased to make up for a shorter working stroke, and the pump capacity thus being held the same. With a 24-inch stroke instead of the former 36-inch stroke, the pumps were speeded to 25 strokes per minute to maintain the 200-g.p.m. capacity.

Power for operation of the changed-over well is supplied by a 25-h.p. General Electric slip-ring induction motor, taking power from a 3-phase 220-volt circuit. While a somewhat smaller motor would have been adequate for the immediate needs of the plant, the size chosen will prove economical, as it will permit the use of considerably larger working barrel with no change in the power end. Means for automatically starting the pumping motor consists of a water-pressure governor, which works in conjunction with an automatic contactor panel.

At the second of the 12-inch wells, water is lifted by a Luitweiler double-acting pump head; capacity, 200 g.p.m. Here power is supplied by a 15-h.p. slip-ring induction motor. In this type of head cams are used instead of cranks, and the pistons working in the same barrel give a continuous flow of water. The motor is geared to the cam shaft, practically all gear noise being eliminated by the use of a rawhide pinion on the motor.

While both of the pumps are used during the summer months, when the afternoon sprinkling period calls all equipment into service, the work is at other times divided so that the automatic head is used only for night work. Provision is made at the switchboard and by means of transformer connection, for uninterrupted service even in case of partial failure of the electrical equipment.



LUITWEILER DEEP WELL PUMP.

In order that the village may not be absolutely dependent on the electric supply, the 8-inch well is still equipped with one of the original steam pump heads.

With the three units the daily production of the plant averages about 130,000 gallons, all of this water being pumped into a reservoir approximately 100 feet above the pumps. The high all-year water consumption at this plant is partially accounted for by the fact that the railroad obtains its local water supply from the city, using about 50 per cent. of the total amount pumped.

For fire use, two high-pressure service pumps have been installed. One of these is a 14x8½x12-inch steam fire pump for emergency service. The other is a DeLaval 1,600 g.p.m. 2-stage centrifugal pump, direct connected to a 3-phase 2,300-volt 1-700-r.p.m. motor. Suction of this unit is connected to the reservoir and, discharged, goes directly into the mains, so that a pressure of 80 pounds is easily maintained.

A high and low-pressure alarm gage is connected to sound an alarm in the attendant's house.

Figures given by the electric company, which concern supplies electric power for the operation of the Richmond and numerous other Michigan pumping stations, bring out a number of interesting facts regarding steam and electric pumping.

Figures are as follows:

LUITWEILER PUMP (ELECTRIC).

Speed	Static Head	G.P.M.	Efficiency
½	180 feet	96	39.6%
¾	180 feet	144	51.3%
Full	180 feet	208	66.1%

AMERICAN PUMP (ELECTRIC).

Speed	Static Head	G.P.M.	Efficiency
½	180 feet	80	42.2%
¾	180 feet	131	52.2%
Full	180 feet	192	63.4%

AMERICAN PUMP (STEAM).

Speed	Static Head	G.P.M.	Efficiency
Full	185 feet	145	23.5%

More detailed figures taken from the plant in the village of Richmond, to which the company sells power, show actual costs where three methods of pumping are carried on under the same conditions, and hence are subject to direct comparison.

PUMPING COSTS AT RICHMOND.

	Deep Well (Electric)	Deep Well (Steam)	Centrifugal (Electric)
Gal. pumped per day	124,031	146,750	14,484
Gal. pumped per kw. hr.	760	.....	1,282
Revenue per 1,000 gal.	$0.035	$0.035	$0.56
Revenue per kw. hr.	$0.026	.....	$0.071
Gal. pumped per lb. of coal	.....	39	.....
Revenue per h.p. hr.	.....	$0.0102	.....

Septic Tank for Small Plants

Suburban communities—particularly prior to the development of regular municipal sewage disposal systems—are very likely to have difficulty in disposing of household refuse properly. The customary method of meeting this contingency is by installing a brick or concrete septic tank underground some distance from the house. This practice, of course, necessitates running the soil pipe at a depth below the frost line. Oftentimes this, together with the loss occasioned by the tank connection, renders it impracticable to take out the discharge pipe at a tank level which will permit the fluid discharging effectively into the final distributing system.

This difficulty is said to be adequately overcome by the Andrews septic tank. The system, in its case, consists essentially of a single 2-chambered tank made of ¼-inch steel plate, with riveted heads and manholes. It is air-tight. Ventilation and gas escapage are effected thru a pipe to the air, thus making it possible to give the tank either a building-basement or outside-surface setting.

A specially-designed cast-iron intake-fitting is securely stud-bolted to the head of the tank, discharge below the scum, and also a cast-iron discharge-siphon fitting of special shape. This latter fitting is a portion of the special discharge apparatus which automatically empties the tank as fast as it fills.

The tank itself is divided into two compartments, all waste being received thru the intake fitting on one side. When this compartment is filled, the contents in turn empty automatically about every 12 or 14 hours by means of a patented siphon discharge-pipe. Both the outlet and inlet are so placed that the contents are maintained in the quiescent state requisite for effective septic action and precipitation.

After discharge from the septic tank, the fluid is carried via soil pipes into a 4-inch sewer pipe, from which lateral branches of 2-inch drain tiles, laid with the joints open about ⅜ inch, are taken. These branches are made from "Y's," assuring an unimpeded flow of nearly equal density over the entire surface of the field. The character of the soil must be of loose, light nature. If it is not, a specially-prepared filter bed must be made.

The above-ground setting of the tank in this system enables the tile and filter-bed to be arranged quite close to the surface, and this feature is of real importance in solving the problem of disposal in wet soils, inasmuch as a special filter-bed can be made of cinders, sand or some other porous material.

In practice, it is claimed that this Andrews system is odorless and not subject to freezing. It is further said that it is necessary to clean out only about two pails of sludge per year.

WORKERS IN THE FIELD

Laying 48-Inch Main Across River

The Editor of MUNICIPAL ENGINEERING:

Sir—After overcoming unusual obstacles, due to an excessive amount of water in the land excavation and to the swift current of the Allegheny river, the immense 48-inch riveted steel water main being laid across that stream from River avenue, on the north side of Pittsburgh, Pa., to Twenty-sixth street, on the south bank, in the old city, is practically completed. All in all, there are in this contract approximately 1,150 feet of pipe, connecting a supply main leading from the new north side municipal reservoir on Cabbage Hill, completed and put into service November last, to Twenty-sixth street and Liberty street. This main is to help supply the lower portion or downtown business section of the city, and parts of the lowlands of the south side and west end of the city. The contract for the furnishing and laying of the pipe in the river was awarded to the T. A. Gillespie Company, of Pittsburgh and New York City, work having been started June 23 last, the contract calling for the completion of the job within six months.

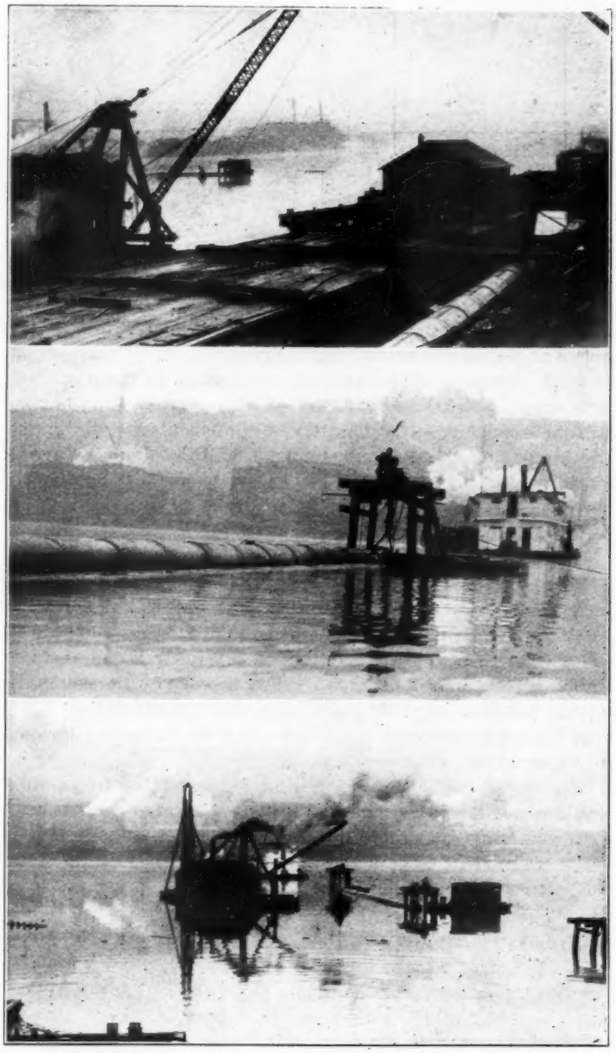
The line crosses the river about two squares above the government lock and dam at Herr's Island, and between the bridge crossings of the Pittsburgh junction railroad at Thirty-third street, and that of the Pennsylvania Lines West, or Pittsburgh, Fort Wayne and Chicago railroad, at Eleventh street.

Four Divers Constantly Employed.

The chief difficulty caused by the current was the maintenance of the excavation and the holding of the pipe in place, work calling for unusual exertions on the part of the divers. The latter had the unpleasant experience of having to work in river slime at the Twenty-sixth street end of the line, owing to the fact that the Twenty-sixth street sewer discharged within 20 feet of the pipe line. Two diving outfits were used, four divers being constantly employed on this phase of the work.

The pipe was loaded on an ordinary Allegheny river barge in 30-foot sections and riveted up there in 120-foot pieces, with a flange at each end. The barge was 160 feet in length. Dead caps were placed on either end of the line, and the pipe joints tested at the specified pressure of 300 pounds to the square inch. Then the water in the pipes was released, the valves closed and the pipe rolled into the water. The laying of the pipes was effected by driving 4-pile bucks at each flange, the line being swung into place by floating under the bucks, slings being placed around the line at each buck. The valves being opened, the water entered the pipe, causing it to gradually sink and become embedded upon the bottom of the trench in the bed of the river. The pipe is of ¾-inch steel. The flanges have ⅛-inch lead gaskets, and are bolted by 44½-inch bolts.

The submarine trench is 10 feet wide at the bottom, the latter being 26 feet below the surface of the river at normal stage. The depth of the trench varies from 10 to 25 feet. So strong was the current at times that it was impossible to hold the pipe steady at some joints, the pipe being swept clear out of the ditch. From two to three days were required to



PITTSBURGH WATER MAIN, READY TO BE ROLLED ON BARGES.

FLOATING 48-INCH PIPE UNDER BUCK, PREPARATORY TO SINKING.

DERRICK BOAT AT WORK LAYING PITTSBURGH WATER MAIN.

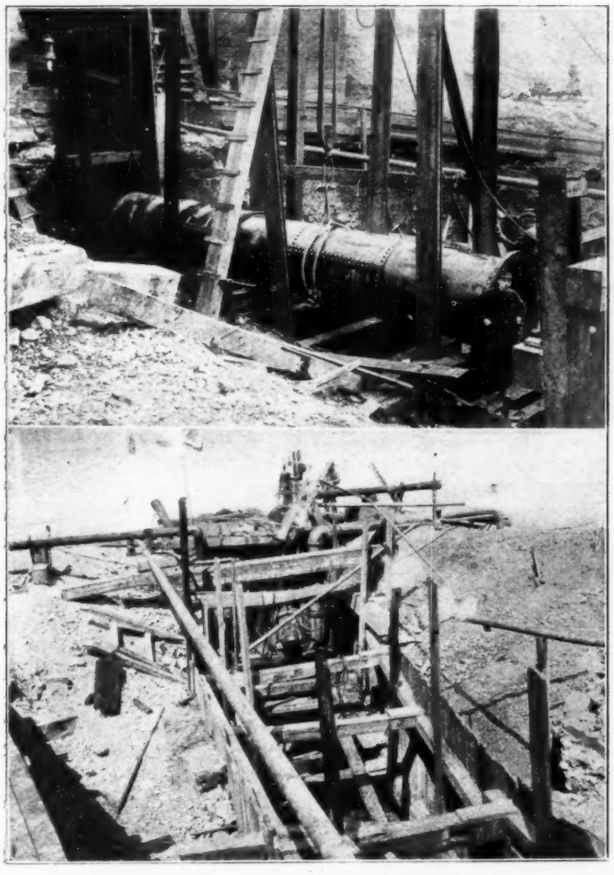
connect up each flange, which under normal circumstances could have been done in ten hours.

The river bottom at this locality consists of sand and gravel.

Machinery Employed.

Two derrick boats, equipped with clam shells, and one dipper dredge were used. Some old wreckage in the shape of iron bridge beams—presumably the grim reminder of some catastrophe or mishap of the past—had to be removed.

A pump chamber, 6x6 feet, the walls of which were ⅝-inch steel plates, was constructed on the old Pittsburgh side of the river, the stream being coffered off with Lackawanna steel sheet piling. This chamber was surrounded with a heavily reinforced 18-inch concrete covering, the reinforcement comprising 1-inch twisted steel rods. Contrary to expectations, heavy water was met with on the land side of the



CLOSE-UP VIEW OF 48-INCH PITTSBURGH WATER MAIN AT WELL.

SECTION OF THE 48-INCH WATER MAIN AT POINT ON THE SOUTH BANK OF THE ALLEGHENY RIVER.

excavation, and it was found necessary to pump 5,000 gallons a minute continuously for over three months. The water boiled up with such force from the bottom of the chamber that it was difficult for the men to maintain a foothold, or, in fact, do their work. The chamber was finished October 22.

The work was done under the supervision of the Bureau of Water, department of public works of the city, Charles A. Finley being superintendent of the bureau.

Requirements of Specifications.

The specifications provided that the steel for plates should bend cold, 180 degrees, or "double flat," when hammered, without showing the least sign of fracture, and should withstand the same test after having been heated to a dull red heat and quenched in cold water.

The tensile strength for plates was placed between the limits of 55,000 and 65,000 pounds per square inch, with an elastic limit of not less than 50 per cent. of the ultimate strength, and an elongation of not less than 25 per cent. in 8 inches, longitudinally of the plate, with a reduction of area of not less than 45 per cent. at the point of fracture of longitudinal sample, which fracture was required to be silky in character.

The steel used in making rivets was required to have a tensile strength between the limits of 45,000 and 55,000 pounds per square inch, an elastic limit of not less than 50 per cent. of the ultimate tensile strength, and an elongation of not less than 27 per cent. in a test bar of 8 inches long. They were to stand bending 180 degrees, or "double flat," both before and after heating to a cherry red and quenching in cold water, without signs of fracture on the convex surface of the bend.

HARTLEY M. PHELPS,
209 S. Neville St.,
Pittsburgh, Pa.

Chicago's Municipal Steam Turbine Pumps

The Editor of MUNICIPAL ENGINEERING:

Sir—The accompanying illustration shows the steam turbine pumps at the Lakeview water works pumping station at Chicago, Ill. Each turbo pumping unit consists of a 20,000,000-gallon centrifugal turbo pump driven by a 600-h.p. steam turbine at 120 feet head with 145 pounds working pressure and 28-inch vacuum. There are also in operation two 75-k.w. d.c. turbo generator sets and four 800-h.p. steam turbines, all designed at Wellsville, N. Y.

It is generally agreed that the pumping sets has many advantages in either the direct-connected form or with herringbone reduction gears. It is pointed out that a few years ago when the only high duty pumping units available were of delicate construction and high speed, engineers turned to motor-driven pumps as a simple and good means for water supply. Within recent years, however, turbine-driven pumps are being more generally used than motor-driven pumps, largely because operating men prefer units which draw their power direct from the boiler at very good steam rate, rather than units which must get their power thru generator, transmission line and motor.

Steam turbine engineers claim that in making a comparison, fairness demands that the generating capacity necessary to operate the pump motor be charged against the electrically-driven outfit. This alone will be something like $25 per k.w., and for an average sized pump brings the initial cost of an electrically-driven unit to almost double that for a turbine unit. In the case of a non-condensing turbine-driven pump, the thermal efficiency of the unit, when exhaust steam is used in the feed water heater, will be in the neighborhood of 95 per cent.

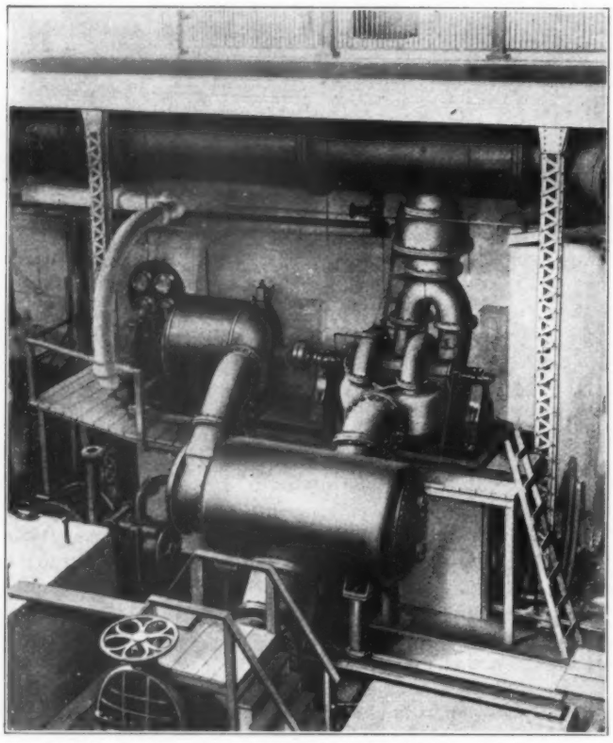
It is held that compared with this, the thermal efficiency of a motor-driven centrifugal pumping unit is actually only about 15 per cent., taking into account all losses in the electric generator and the driving motor. This large difference is due to the simple fact that the exhaust steam of the turbine can be put directly into a feed water heater without fear of danger from oil to the tubes of the heater or to the boiler, according to the type of feed water heater used.

It is urged that when pumps or other auxiliaries are driven by a steam turbine, all the heat excepting that slight amount lost by radiation which it does not convert into useful work is returned to the boiler. Many engineers held that all auxiliaries should be steam-driven, so that the exhaust may be used for a feed water heater. In this way the auxiliaries may operate at about 80 per cent. thermal efficiency. Should the pump drop off in efficiency, the motor is liable to be badly overloaded in obtaining the same amount of water. A steam tur-

bine, on the other hand, is designed to carry large overloads, and when fitted with an overload type, the turbine easily carries one and one-fourth times the rated load.

Speeded to Accurate Control.

It is undoubtedly true that a most important advantage of the turbo pump lies in its ability to be speeded to accurate control. Speed change which controls the quantity or head is very easy, although practically impossible with an alternating current motor. Water supply and head are seldom exactly constant, so the importance of this advantage is clear. There are instances where alternating current motors have been installed, and, due to some slight change, have become totally unsuited for their work. As an example: A prominent rubber company installed a motor-driven pump to deliver 1,000 gallons per minute under 80-foot head. Later this firm wished



STEAM TURBINE PUMP FOR CHICAGO STATION.

to increase pressure in the plant and operate the pump at 80 pounds. This was impossible with the motor whose speed was limited to 1,800 r.p.m., as it was an a.c. 60-cycle motor; but by substituting a steam turbine and speeding the pump up from 1,800 to 2,600 r.p.m., the desired pressure was obtained.

Have Demonstrated Reliability.

It is of interest to note that the turbine-driven centrifugal pumps as standby units in water works service were advocated in Europe as early as 1905, and installations abroad and in this country have now demonstrated reliability and ultimate dollars and cents economies, fully as good as from the best triple expansion units, both in standby and constant service installations.

It is held that the demand on one pumping station in this country involves 60 per cent. of capacity 295 days per year, 60 to 80 per cent. of capacity 48 days per year and 80 to 100 per cent. of capacity 23 days per year. In other words, 40 per cent. of the plant is not needed 295 days per year, a figure broadly right for the average plant.

There is a 7,200,000-gallon turbine-driven water works pump installed by the city of Youngstown, Ohio. The pressure head is 90 to 110 pounds and the speed 1,600 r.p.m. Under test, the duty obtained was 11.2 per cent. better than the guaranteee of 80,000,000 foot-pounds per 1,000 pounds of dry steam. The city of Youngstown also purchased a triple expansion reciprocating pump for the same conditions, except that the duty guarantee was 163,000,000 foot-pounds. The cost of the turbo pump was about $10,000 and operating costs $9,400 per year, as against $72,000 and $14,000, respectively, for the reciprocating pump.

A modern steam turbo pump requires to carry excess over the 60 per cent. to carry the peaks, to quickly increase pressure and quantity output for fires or to operate during temporary shutdowns of a main unit, just about one-fourth as much of an investment as for a reciprocating pump, foundation and buildings to provide equal capacity increase. In standby units, even where the price of coal is high, and if the steam consumption of the turbo pump should be slightly greater than that of a reciprocating pump during the working periods, so little is added to the fuel bill that this extra expense is less than the interest on the increase of investment that would be necessary for a reciprocating outfit. With coal at low price, the turbine is actually capable of very much better total over-all economy as a main unit is a high-grade triple expansion pump.

It is well known that the turbo pump requires practically no attention or expense for maintenance, and is the simplest piece of apparatus in the plant. There is nothing about the outfit that gets out of order easily and causes failure of the apparatus at a critical time. There is no danger of damage or sticking of cold parts from sudden admission of steam. A turbo pump started from rest pumps as long as steam is supplied to the turbine. Steam turbo pumps for similar reasons are also highly desirable as standby units in hydro-electric plants that have an auxiliary steam plant to help out during periods of low water or in the case of failure of hydro-electrically-driven pumps for any other reason.

It is claimed that the turbo boiler feed pumps are of great value, as these pumps work against comparatively high pressures, and they run at the high rotative speeds favorable to direct connection with the turbine.

They require much less steam to do a given amount of work than is required by a reciprocating pump, and with the latter a steam consumption of 100 pounds per b.h.p. is by no means uncommon. Turbo pumps in this service work well in connection with automatic feed water regulators, as the pump speed can easily be changed automatically to deliver the right amount of feed water at the required pressure. A turbo pump can also be paralleled with a reciprocating pump, and the two so governed that the reciprocating pump automatically starts when the other pump becomes overloaded.

A great field for turbo pumps is found in condenser work. For driving centrifugal pumps to deliver a large volume of water against a low head, as in supplying surface or jet condensers, geared turbines give a splendid steam economy by proper choice of speed ratio. Where gears are not interposed, the matter of speed is often a compromise, as pump speeds in this service may be low for the turbine. Turbo pumps are also used to handle the condensate, in which instance the operation of the pump can be made entirely automatic. This is accomplished by putting a float in the hot well and operating therefrom a throttle valve in the steam line of the turbine. The center of the pump should be at least 3 feet below water level in the hot well to assure priming and the discharge head should be over 25 feet.

It is claimed that such installations have proven very satisfactory in service, and the present tendency in power plant design is to use more and more steam turbine-driven pumps on condenser work. It is sometimes practical to mount both circulating and hot well pumps on one shaft. For mine drain-

age also the steam turbine-driven centrifugal pump is well adapted, as the space occupied is small and parts of the pump which come into contact with the water handled can be made of any desired acid-resisting material. With electric motor-driven mine pumps, flooding usually means not only an immediate shutdown of the pump, but if other motors or lights are on the same circuit, the opening of the circuit-breakers or fuses puts all these out of commission.

FRANK C. PERKINS.

Cable System Handles Dump Wagons

The Editor of MUNICIPAL ENGINEERING:

Sir—"Old Dobbin" in these days of efficient and fast moving motor truck is being rapidly crowded from urban grading jobs. Once in a while, however, thru some mechanical aid he is enabled to cope with this modern mechanical wonder. This article has to do with just such a case. Briefly, the work performed was the hauling of rock in 2-yard Troy wagons up a 16.5 per cent. grade, by means of an auxiliary cable—attached to the wagon—which made the load handled by the team almost negligible. Connecting this same arrangement of cable on another part of the work allowed the team to descend a 28.75 per cent. grade without setting the brakes and with comparative ease.

This ingenious method of handling the material was evolved by Al. Hennessy, the outside superintendent of the Federal Construction Company, and was used on a grading job that this firm had been awarded in San Francisco.

The work was done under public contract under a two-year installment plan, at a total cost of $39,517.55, and involved moving 58,677 cubic yards of material, of which 13,087 yards were in slope. The contract was completed June 13, 1916.

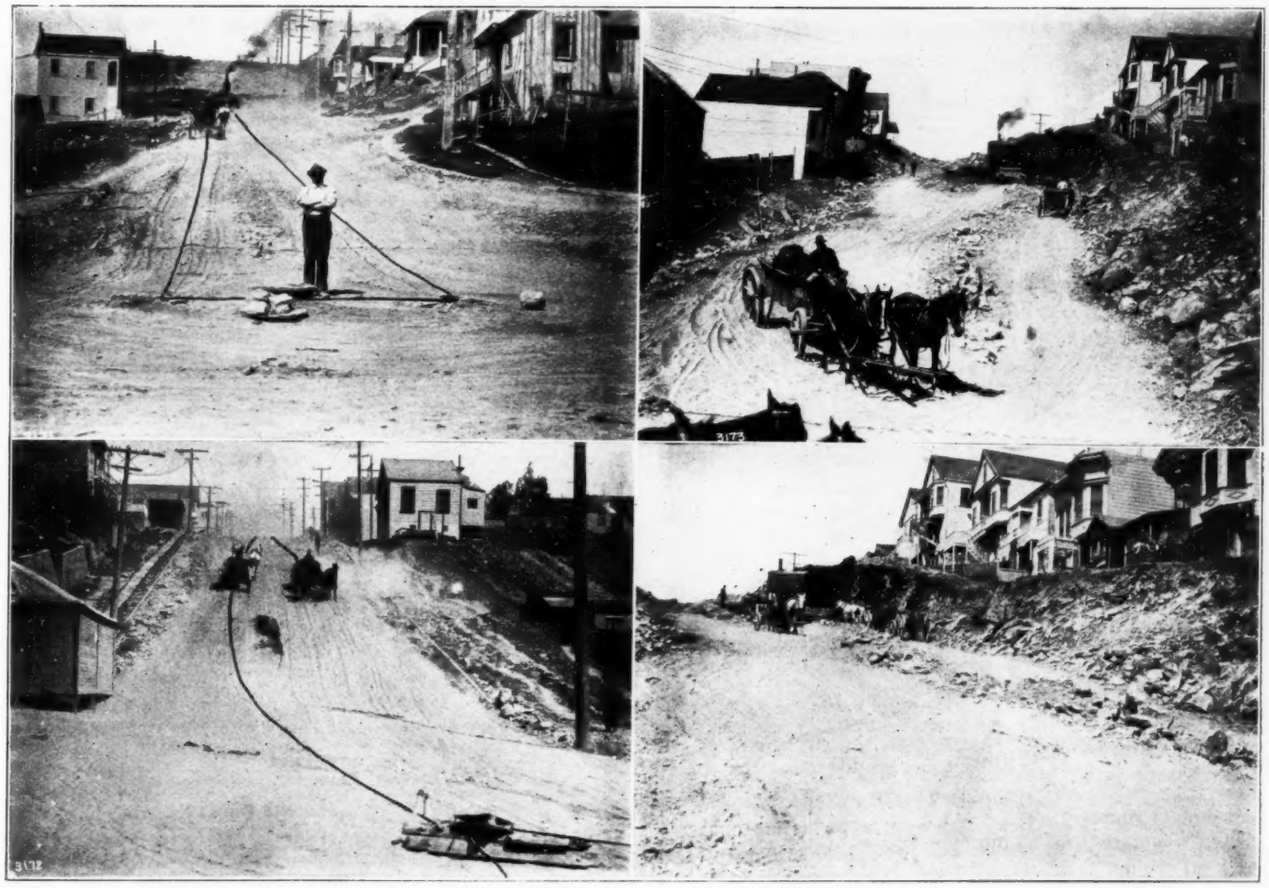
Owing to the peculiar topography of this district (see views), some such method of handling the material as was adopted was necessary in order to show profit. Fortunately, a short haul was available, the contractors having made arrangements with the owners to fill some of the low land adjacent to the streets graded. On Vermont street, some very heavy fills were made, necessitating raising a number of houses to the new grade.

Using the method herein described, the contractors were enabled to make the fill at small expense to themselves.

A small donkey engine (with engineer and helper), a few hundred feet of ½-inch wire cable with hooks attached, and several deadmen and pulleys were all the extra equipment necessary.

Nearby, another grading job was in progress, under the supervision of the city, on which 5-yard motor trucks were used. The haul, however, was much longer, and consequently the cost was much greater. It afforded a good opportunity to compare the two methods, as both jobs were in plain sight from the high ground. It was impracticable to use cars on account of the steepness of the ascent, this being one of the difficulties that were directly responsible for the working out of the economical method described.

JAMES M. OWENS, Asst. City Engineer,
City and County of San Francisco, Cal.



TWENTY-SECOND STREET, NEAR RHODE ISLAND STREET, 28.75% GRADE. SHOWS LOADED WAGON COMING DOWN GRADE.

VERMONT STREET, BETWEEN TWENTIETH AND TWENTY-SECOND STREETS. WAGON BEING ASSISTED UP 16.5% GRADE.

CAROLINA STREET, NEAR TWENTY-SECOND STREET. STEAM SHOVEL; ALSO WAGON WITH CHAIN ATTACHED TO REAR AXLE. THIS CHAIN WAS ATTACHED TO A HOOK ON THE CABLE.

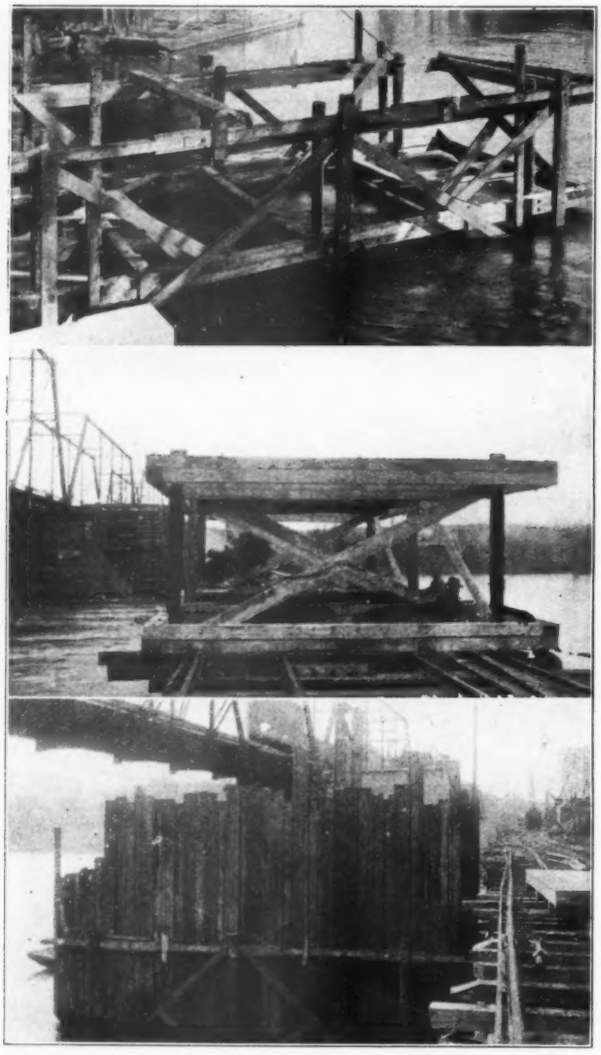
CAROLINA STREET AT TOP OF GRADE, SHOWING CHARACTER OF MATERIAL.

Outside Templates on Steel Cofferdams

The Editor of MUNICIPAL ENGINEERING:

Sir—The outside template shown in the accompanying views was built by the writer and used repeatedly in setting up and guiding the new steel sheeting for successive cofferdams required in constructing the piers for the Susquehanna river bridge, recently completed by the Robert Grace Contracting Company for the Philadelphia & Reading railroad at Milton, Pa.

The new bridge was built parallel to and directly above the old bridge, and great quantities of large riprap stone placed to protect the old piers were encountered in the 8 to



VIEWS SHOWING COFFERDAM FRAME AND SHEET STEEL PILE TENPLATE AND PILING.

15 feet of soft material that overlay the rock beneath the river bed. This made it difficult to set the steel sheeting to correct line before driving and obliged the writer to devise the template shown.

This template was an outside frame of timber 6 inches larger all around than the cofferdam bracing itself. The bracing assembled with the frame of the template was built on the work trestle, and set in place by a 30-ton locomotive crane. The wales of both the bracing and template were made of doubled 6x8-inch oak timbers, with lengths of round wood piling as upright supports and 2x10-inch yellow pine cross-braces. The template not only made it possible to set up and drive the steel sheeting true to line, but furnished a good foundation for working platforms.

After all the sheet piling at one pier had been driven, the template frame was removed by the locomotive crane and used again at the next pier site. One frame was used successively on all of the 20x40-foot cofferdams.

F. P. KENNON.

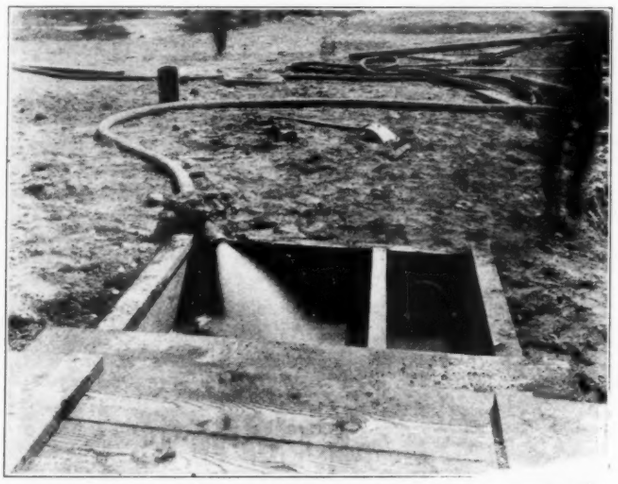
Cleaning Out Sand Catchers

The Editor of MUNICIPAL ENGINEERING:

Sir—The following is a short description of the method used in cleaning out the large sand catchers of the sewer system of the city of Seattle.

Because of the large amount of sand, gravel and other heavy detritus that gets into the sewers, it was necessary to put in large sand catchers (or grit chambers, as they are called by some engineers) in the line of the sewer.

During the rainy season, these sand catchers, which hold from 20 to 50 cubic yards of detritus, require cleaning about every ten days. This was a very expensive and disagreeable task, taking seven men and a team on an average of three days to complete the same. Mr. George Otterson, a mining engineer of Seattle, suggested that the problem could be solved by the use of a hydraulic ejector. This ejector works on the same principle as any ordinary hydraulic lift, having a water supply pipe connected to a nozzle which throws a stream of water at high velocity thru a contracted throat, thus creating a vacuum and causing a suction. The height that sand and gravel can be elevated by this ejector is governed entirely by the pressure of the water supply. It is very simple in its



SETTLING BASIN, SHOWING POSITION OF OUTLET PIPE BACK TO SEWER.

construction, as can be seen from cut. There are no movable parts to get out of order. All wearing parts are made of hardened steel, thus insuring a life of several years before they have to be replaced. When this is necessary, it requires but a few minutes' time to slip the old parts out and put the new ones in place.

Collects in Settling Basins.

With Mr. Otterson's ejector it requires but three men for one day, at a labor cost of $9 and water cost of about $3 to clean out both sides of a sand catcher holding about 22 cubic yards. The sand and gravel and all foreign material are thoroly washed by the large quantity of clear water used in lifting them to the surface. They are collected in large settling basins built on the surface, from which they are easily shoveled into wagons.

Because of the thoro washing, all offensive matter is re-

moved, and the clean sand can be dumped in any convenient place. The use of the settling basin is temporary. It is expected that a suitable wagon will be built and the material deposited direct from the ejector into the wagon. The surplus water carrying organic matter and light material is conducted back to the sewer by means of a suitable drain pipe and hose.

A. W. HOWARD, Seattle, Wash.

A Steel Surfaced Pavement

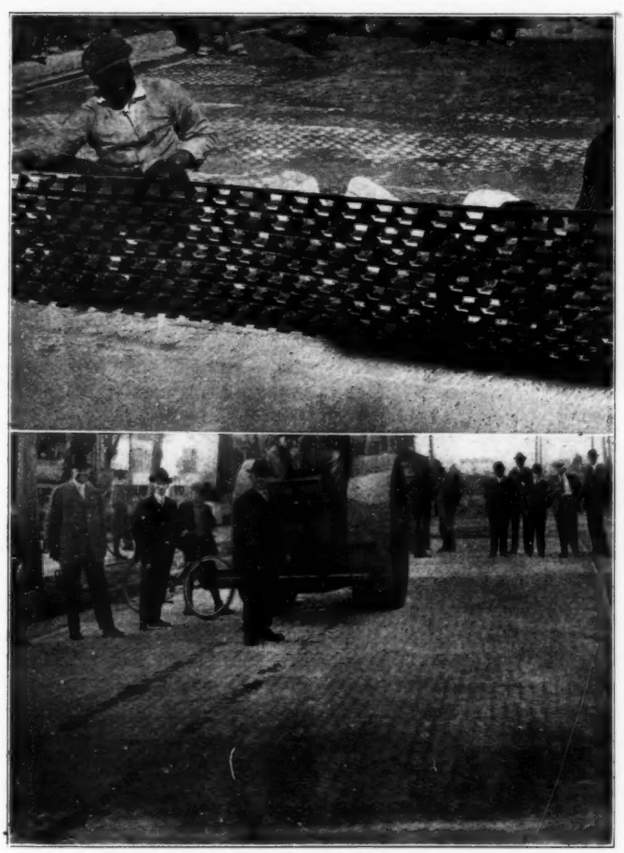
The Editor of MUNICIPAL ENGINEERING:

Sir—We have a macadam roadway on West avenue, reinforced or armored with steel surfacing, covering an area 18x80.34 feet, or 160.68 square yards. The pavement is on one side of the car track, which is in the middle of the avenue. It is on a 4 per cent. grade.

Since this type of pavement is entirely new (at least in my experience), there are no precedents to follow in its construction, and it was necessary to employ methods suitable for actual conditions. The completed pavement comprises a base 4 inches thick, of crushed stone, compacted with a 10-ton steam roller; 3-inch thickness of concrete, with aggregates not exceeding ¾-inch size, mixed 1:2:4, and the steel surfacing set flush with net grade. The surfacing is made from steel plates, 2½x18 feet and ⅛ inch thick. The crushed stone base cost 30 cents per square yard, and the perforated plates cost $50 per ton. The actual cost of the work is as follows:

Base 4 inches thick	$ 48.00
Materials for concrete bed 3 inches thick	61.90
Steel surfacing delivered	180.77
Labor, including overhead expense	40.00
Total	$330.67

Unit cost, $2.06 per square yard.



SECTION OF STAMPED STEEL SURFACING.
VIEW OF NEW LAID STEEL PROTECTED PAVEMENT.

The two photographs show construction and finished work respectively. About two weeks after completion we ran a 10-ton steam roller over the surface to test for adhesion between steel and concrete. No movement was perceptible and, at the present time, the pavement is apparently in perfect condition.

SAMUEL H. LEA, City Engineer,
City of Charlotte, N. C.

Details of Gypsum Roof Deck

The Editor of MUNICIPAL ENGINEERING:

Sir—The following information describes a new development of fireproof roof construction, as found in Walker Manufacturing Company's roof at Racine, Wis.

Style of building—steel frame, 190x200 feet. Roof slabs made of Structolite, a new form of extremely hard, dense structural gypsum, molded on the job. T-section 15 inches wide, 8 inches deep and 1¼ inches thick for the slab and 2½ inches for the rib. Ends closed by diaphragms 2 inches thick. Reinforcing consists of two ⅜-inch rods on bottom of rib, one of these being bent up at the ends as a shear rod and looped to increase the value of bond stress. In slab is embedded a steel wire mat of No. 14 gage, 4-inch mesh.

Erected under the supervision of the United States Gypsum Company; Architect P. L. Battey, chief engineer; B. J. Arnold Company, consulting engineers, Chicago, who were also contractors.

Slabs molded at rate of 300 square feet per hour. Slabs taken from molds fifteen minutes after being poured were walked upon three hours after being poured; designed to carry a uniformly distributed load of 50 pounds per square foot, with a safety factor of four.

Slabs carried by light steel trusses for saw-tooth portions and by steel purlins for flat portions, supporting steel spaced 10 inches from center to center. Flat roof portion has a pitch of 1½ inches in 12 inches.

Weight of T-beam slabs 16 to 17 pounds per square foot. Slabs may also be made of I-section when flat ceiling effect is desired, instead of ribbed or beam ceiling. A roof of this character is now being erected. Beams are 22 pounds per square foot.

Five sample beams 24 hours old were tested with loads of 2,200 to 2,400 pounds, or 200 to 218 pounds per square foot, deflected 0.034 and 0.070 inch; 3,500 pounds caused light horizontal shear cracks only.

Advantages of this new roof: Light weight, rapid erection in all kinds of weather, non-conducting and non-condensing, deflection of light from the white under side, and economy, the Structolite slabs being inexpensive and the steel framing used to hold the slabs in place costing less than 5½ cents per square foot.

GEO. L. LINCOLN.

Will Help Locate Plants.

The Industrial Sites Association of America, with offices at 115 Broadway, New York, has recently been reorganized and incorporated. The entrance of this association into a new field of action solves a problem of long standing for manufacturers who are in quest of new locations.

The I. S. A. A. has undertaken to meet this need by compiling and classifying data concerning the properties, sites, buildings, railroad and water facilities, labor conditions, population, etc., of all towns and cities where manufacturing plants could be advantageously established—a clearing house which would supply manufacturers with complete and verified information free of charge.

By simply stating their requirements manufacturers will be rendered every assistance in the location and selection of properties. They will be given free access to all data in the possession of the association. The entire service is offered without charge of any kind.

MISCELLANEOUS

Conversion of Settling Tanks Into Imhoff Tanks Thru Use of Light Steel Forms

Without causing a complete shutdown at the Columbus sewage treatment plant, the original settling tanks were converted into Imhoff tanks by the use of light steel wall forms in standard units, supplemented by specials for intersections of surfaces in different planes. While half of the tanks were being modified, the other half were continued in operation, taking the entire flow of the plant. The outer walls of the original tanks were left in place and were used as the outer walls of the Imhoff tanks.

The contractor for this work, D. W. McGrath, of Columbus, Ohio, used Blaw light wall forms for practically all of the new work, excepting the end channels for the admission and outflow of the sewage. The latter were of such variable form as not to permit a sufficient amount of re-use of the forms to justify the use of steel.

The first operation consisted of excavating below the bottom of the old tanks, and constructing pits with concrete walls and sumps in their bottoms for the collection of the sludge. The forms were set up for one of these pits complete, a height

VIEW SHOWING FORMS IN PLACE.

of 8 feet above the top of the sump. These forms were filled and removed before the wall was carried up higher, being used again on another sump as soon as they were taken away from the first one constructed.

The illustration shows the Blaw steel forms filled with concrete for the construction of one of these sumps. The system of liners holding the forms rigidly in position is well shown, and it will be noted that on the overhanging wall the liners are bent so as to produce a wall of exactly the right profile.

The forms used on this work were, with the exception of the specials provided for the intersections, strictly standard light wall forms, adjustable for use on all plain wall work, where the height poured at any one time does not exceed 10 feet. These forms were attached to the liners before they were erected, and were shifted either in units 2 feet wide and 10 feet, 12 feet or 14 feet long, as desired, with the horizontal liners attached or in larger units with the vertical liners attached, in which case it was necessary to employ a derrick to handle the form on account of the weight. The form weighed about the same per square foot of surface as a well-made wooden form, but occupied less space and had much greater stiffness.

On this particular job the forms used in the sumps were shifted by the derrick in units 12 feet wide by 8 feet high or 96 square feet to a unit, similar units being used in the upper sections. In shifting these large units they were picked up by the derrick and swung around into a new place wherever desired, necessitating little handling.

Getting at the Haulage Cost

In an article recently appearing in the *Federal Traffic News* the basis of figuring cost per mile and dividing this cost into its component parts for purposes of comparison, has been quite clearly brought out. By the use of two diagrams the division under various conditions is very plainly shown. For a basis of cost determination the 1½-ton Federal truck is used.

On a basis previously worked out the total operating cost of the truck is divided into ten parts, five of which are fixed charges—that is, charges which remain the same for every day—and five variable charges, those which depend on working conditions usually grouped under the one head of mileage.

The various items under these two heads are:

Fixed	*Variable*
Driver	Fuel—gasoline
Interest on investment	Lubricants
Insurance	Tires
Garage rent	Repairs and maintenance
Taxes and license	Depreciation

Of all these items but one would be questioned. Many still contend that depreciation should be figured as a daily fixed charge. It may be the easier way, but this way does not always prove the best or right way. The practice of many is to charge off depreciation as soon as possible. Fifty per cent. the first year and 25 per cent. the next two years is a common practice. Any such plan would not seem so bad if the transportation costs were averaged over the entire life of the truck, but where one year is to be compared with another, the first year is at a disadvantage to all others. For the sake of a fair average it is the plan of many, including ourselves, to figure depreciation on a mileage basis.

The mind of business, thru its big men, is gradually coming

to the point where it asks, not what an article costs, but what it will do for its cost in solving our problems. We expect a certain unit of value for a unit of investment. In our transportation problems this has developed the cost per ton and the cost per ton mile, or their variations which best fit the different lines of business.

Facts That Must Be Known

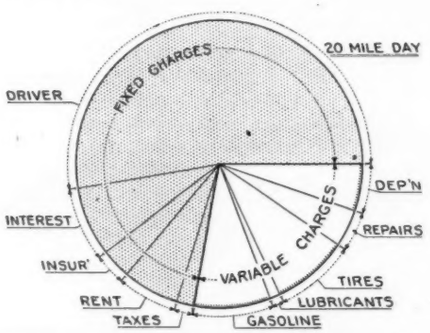
Before such costs can be satisfactorily computed a few very important items must be known, the following being the most common:

Miles of travel per day.
Tons carried per load.
Miles per round trip.
Trips made.
Deliveries made.
Hours per day.

With this data and the two charges, the daily fixed and the unit mile, we can proceed to determine our costs. The illustration reveals two important points, which we will do well to keep in mind:

First—The greater the daily mileage, the greater will be the proportion of variable charges in the whole cost.

Second—The greater the daily mileage, the less burdensome are the fixed charges in the total cost.



THE RATIO OF COST IN A 50-MILE DAY.

In the 20-mile day the fixed charges are nearly three-fourths of the entire cost. In the 50-mile day the fixed charges are only about one-half of the total cost. If we carry the same idea a little farther, we find that in a 10-mile day the fixed charge is 84 per cent. of all cost, while in a 75-mile day it is but 42 per cent.

The reason for this can be found in the fact that variable charges increase in a direct proportion to the daily mileage, while fixed charges per mile decrease in proportion to the increase of daily mileage. This will readily be seen by a few figures:

VARIABLE CHARGES

Miles per day.....	10	15	20	25	30	35
Cost per day.....$	.72	$1.08	$1.44	$1.80	$2.16	$2.52

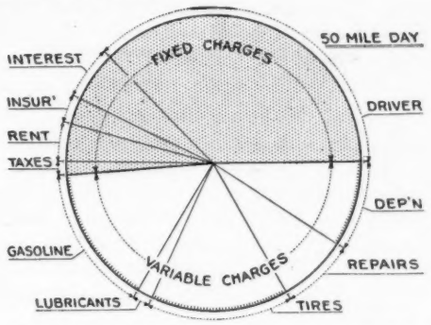
FIXED CHARGES

Miles per day.....	10	15	20	25	30	35
Cost per mile.....$	.35	$ .23	$ .17	$ .14	$ .12	$ .11

Other Factors

If the cost per ton-mile is figured according to the half-load basis by multiplying the average load in tons by one-half the daily mileage, this cost, on which basis we compare trucks, will vary greatly. This is because the factors composing this cost are variable factors. Loads, miles and daily cost, the variable factors in this cost problem, explain in themselves why costs vary.

One concrete example will make the statements plain. A 2-ton Federal, owned and operated in Reno, Nev., during three days of July, carried an average load of 3,025 pounds and made an average of 59.66 miles per day. The cost for each day's work was $8.96. The cost per ton-mile for the load carried in this case is $0.198.



THE RATIO OF COST IN A 20-MILE DAY.

We can find this by reducing the load to tons, multiplying that by one-half the daily mileage and dividing the result into $8.96.

3,025 lbs. = 1.512 tons.
1.512 × (59.66 ÷ 2) = 45.1 ton-miles.
$8.96 ÷ 45.1 = $0.198.

If a capacity load of 4,000 pounds had been carried, the cost per ton-mile would have been reduced to $0.15. Cost figures must be understood if they are to be of the most value.

Heavy Trucks Cause Vibration

Proposals of considerable importance and of not a little interest to metropolitan road engineers are contained in the following memorandum on the construction of motor omnibuses which has been issued by Sir Edward Henry, the commissioner of police for London:

"The commissioner of police of the metropolis, as the authority for licensing public carriages, desires to make the following representation with regard to the future construction of motor vehicles intended for licensing as motor omnibuses within the metropolis area.

"By the heavy motor car order, 1904, it is enacted that the maximum unladen weight of a heavy motor car may not exceed five tons and, if it is to be operated up to 12 m.p.h., the registered axle weight of any axle may not exceed six tons. In the past it has been found that the passage thru the streets of motor omnibuses approaching the maximum of unladen weight and of permissible speed caused much annoyance and damage thru noise, vibration, etc., tho fitted with rubber tires, as provided by the order.

The Unladen Limit.

"Acting upon expert advice, the commissioner, in 1909, after a conference with manufacturers and users, laid down a rule that no new vehicle would be licensed for public service which exceeded 3½ tons unladen weight, or, alternatively, exceeded a gross weight, fully laden, of 6 tons. Even with these limitations of weight, complaints of damage and annoyance continue, and the time appears opportune for reviewing licensing requirements, as the demand for chassis and parts consequent upon the war having exhausted old stocks, new construction will, when circumstances permit, have to be undertaken before new vehicles can be put upon the market.

"The experience and the developments of the last six years in the mechanical properties of materials and in designs of structural details lead the commissioner to anticipate that it will be possible to construct vehicles to meet the requirements of the public service in London with a lower laden and gross weight than 3½ and 6 tons, respectively. It is well known to manufacturers that since 1909 methods of production of gearing have been developed, which will make it practicable to

obtain silent and efficient working with lessened total weight of transmission mechanism, and some reduction may be expected in the total weight of power and of transmission mechanism thruout. Attention is also called to the method of inside lighting and of outside advertisements, as it is possible that saving in weight in connection with them might be effected.

Makers' Co-operation Invited.

"The commissioner deems it necessary, therefore, to give timely notice that new vehicles presented for licensing must be of a type differentiated from existing types by being lighter in weight, and with a better form of power transmission. He invites the co-operation of manufacturers in designing and constructing vehicles which can operate in the streets without affording grounds for complaints as to the damage done to residential property by the excessive vibration they cause, owing to their weight, and as to the annoyance caused by faulty power transmission.

"The interests of the community and of the operating companies in this matter are the same, as the introduction of a perfected type of vehicle would greatly popularize the omnibus service, to the benefit of both the operating companies and the public. The commissioner feels sure that he can in these circumstances rely upon the cordial help of manufacturers. Any representations they may put forward will, of course, receive the most careful consideration.' '

Cutting Down Finishing Costs.

Comparative costs between hand floating and finishing by the belt method, which has been recently advocated and successfully used in Wayne County, Mich., and other points, show a decided reduction in costs and truer finish with the use of the belt method. This method consists of the use of two or three canvas belts, slightly longer than the width of the road, which are worked across the road with a cross wise and longitudinal motion, resulting in well compacted, dense concrete, with a true surface.

The comparative costs are set forth in a very interesting record kept on a job in Kenton County, Ky., as follows:

By Hand Float Finish, First Class Job:

Finishers, 12 hours, at $0.50	$ 6.00
Assistant finisher, 12 hours, at $0.35	4.20
Cost per day	$10.20

Average cost per square yard, 1.7 cents.

By Belt Finishers, First Class Job:

Finishers, 10 hours, at $0.35	$ 3.50
Assistant Finisher, 8 hours, at $0.25	2.00
Cost per day	$ 5.50

Average cost per square yard, 0.9 cent.

New "Pivot-Lock" Manhole Cover

Liability risk as it existed with the old-style loose manhole cover can now be entirely eliminated by the use of a pivot-lock cover recently placed on the market. The device consists of a locking and operating mechanism which is applicable to all street and sidewalk cover plates as used by street, sewer and water departments of public utility companies. It is also used as a coal hole cover.

There are only three working parts in the device, and these are inclosed in a moisture-proof, dirt-proof housing. As the parts are packed in grease, there is little chance of rusting or sticking.

To remove one of these pivot-lock covers the operator has only to insert a "T" handle wrench in a key slot cut near the edge of the cover. This operation not only unlocks the cover, but raises it clear of the rim, also rotating it back, away from the manhole. By reversing the operation the cover is seated in place again. The key wrench cannot be removed from its socket until the cover is seated and locked. As the lifting power is applied to the under side of the cover, there is no opportunity for ice or rust to resist the proper working of the mechanism.

New Covers Used in Street Cleaning

One unique application of the new cover bears promise of a wide use. This is in connection with the efficient removal of street sweepings. In carrying out the new plan, all above ground sweeping receptacles are dispensed with. In their place fly-proof, wind-proof underground receptacles are set beneath the street or sidewalk level. The pivot-lock cover gives the sweeper easy access to the receptacles, at the same time protecting the pedestrian from all danger.

These receptacles should be evenly distributed thruout the beat of the sweeper, so that when he starts his work in the morning he finds an empty can in each receptacle. He then places one upon his push cart and starts cleaning up. After

PIVOT LOCK MANHOLE COVER.

filling his can, he would go to the nearest receptacle, open it with his key wrench and dump his full can into the empty can the receptacle contained, and close the receptacle over, hanging his key wrench on his cart and go about his business without any waste of time. The time saved enables him to take care of considerable larger area than by the ordinary method, thus cutting down the sweeping force necessary.

At night a pick-up wagon or truck equipped with a swinging arm and a set of falls, comes around and backs up to the curb. The falls are equipped with bale hooks which are hooked to two bales on the inside of the cans. The cans are hauled out and placed on the truck and carted off to the dump, emptied and brought back for the sweeper to use the next morning. The cans are at all times protected from battering and should last much longer than under ordinary conditions.

Relief From Excessive Traffic

By Eugene W. Stern, Chief Engineer, Bureau of Highways, Boro of Manhattan, City of New York.

On certain streets of all busy cities the number of vehicles is so great and the resulting congestion is so serious that students of this problem have become much alarmed and are discussing the need of more effective traffic regulation. The easiest solution of this problem appears, however, to be the better diffusion or distribution of traffic, and this can in no way be more effectively brought about than by a better and more uniform standard of improvement of the roadways of both urban and rural highways.

Why is it that so many drivers of vehicles tend to use the same street when many different possible routes could be followed? Undoubtedly the chief reason is that they wish to

use the streets that are best paved. In the case of the motor vehicle a slight detour with corresponding increase of distance is of little consequence, and time will actually be saved by the avoidance of traffic congestion; but those who are riding, especially for pleasure, prefer to follow the streets that are most attractive, those on which the abutting property has been improved to a higher degree and in a little more sightly manner. When our streets shall have become uniformly well paved and when the property along them shall have been improved according to better standards—not necessarily with palatial homes, but with good taste—when tree planting is taken up more seriously and when the space not needed for roadways and footpaths is devoted to grass plots or planted with shrubbery, those with whom time is not the important element will follow these streets, now given over wholly to the delivery wagons of the milkman, the grocer and the butcher, and appreciable progress will have been made in the solution of the traffic problem. There is, however, a very serious problem which has grown out of the use of motor vehicles; namely, the increasing weight, the increasing wheel loads and the increasing size of these vehicles. The motor or the tractor can overcome grades with heavy loads which are impossible to the horse-drawn vehicle, and highway officials responsible for the maintenance of our city streets and of the country highways leading out of them are greatly concerned at the damage inflicted upon road surfaces by these loads. The only effective remedy appears to be the enactment of drastic ordinances and laws which will absolutely prohibit the use of vehicles having more than a specified load per inch width of tire, and that load should probably be less for steel tires than for rubber tires.

The width and length of such vehicles is a matter of serious concern, especially on city streets. Where roadways have been designed to accommodate a certain number of lines of traffic and the number of lines is reduced thru an increase in the width of the vehicles, the capacity of the roadway is reduced in still greater proportion; and if this increase in width is allowed to proceed, very costly street widenings will become necessary. In this case, also, it would appear to be necessary to prohibit absolutely the use of our highways of vehicles having more than a certain specified width. The state legislature of Pennsylvania in 1913 passed a law prohibiting the registration of motor vehicles exceeding 90 inches in width of load and vehicle combined, except that motor buses for carrying passengers may be used within the limits of cities of the first, second and third classes, having a total width of 100 inches. This law also prohibits loads in excess of 24,000 pounds for vehicle and load combined or in excess of 18,000 pounds gross load on any axle, or 750 pounds for each nominal inch of width of solid tire.

Fortunately, the tendency of the manufacturers of motor trucks appears to be in the direction of more moderate loads. Of 221 manufacturers producing commercial vehicles at the beginning of the present year 133 confined themselves to those of less than three tons capacity. Of the 88 manufacturers offering trucks of more than three tons capacity, 12 appear to have increased this capacity in their models for this year, only two of these increases being to six tons, while six have decreased the capacity of their trucks, one from four to three and one-half tons, three from five to three tons, one from six to four tons and one from seven and one-half to five tons. Of twelve newcomers in the field, only one offers a truck with a capacity of six tons and two of five tons, while the rest provide for smaller loads.

While the imposition of an absolute limit upon wheel loads and upon dimensions of vehicles seems necessary to preserve our highways, both in the city and country, the development of the motor vehicle appears on the whole to present no problems to highway officials, especially problems relating to street congestion, which will not solve themselves with the more general improvement of our streets and roadways and with the adoption of a higher standard of real estate development, which will make the subsidiary highways more attractive to those using motor vehicles.

Income and Wealth.

According to the monthly letter (June, 1917), of the Alexander Hamilton Institute, Great Britain has raised by taxation but 25.3 per cent. of her war cost. This means that 74.7 per cent. was raised by a bond issue.

In spite of this precedent, however, our House of Representatives formulated a bill admitted by itself to be unscientific, which planned to raise but 40 per cent. of our immediate money by bonds and 60 per cent. by direct taxation of capital and industry.

Great Britain with a total wealth of eighty-five billion dollars has financed the war for three years. With our two hundred and fifty billion of wealth, we have little to fear even tho we are facing the possibility of financing it for the next three years, tho of course, there is no chance of our having to do this. Especially is this true when we consider that our national income is thirty-five billion dollars against Great Britain's eleven billion dollars and our national debt less than two billion dollars against Great Britain's nineteen billion dollars.

The United States enjoyes the best credit among the nations of the earth. Our national debt is less than 1 per cent. of our national wealth, and new taxation of two billion dollars during the coming year would consume only about 6 per cent. of our national income. The following table shows our financial strength in comparison with that of Great Britain, whose credit ranks highest in Europe:

	United States	Great Britain
Wealth	$250,000,000,000	$85,000,000,000
National debt	1,700,000,000	19,000,000,000
Per cent. debt on wealth	0.60%	22.35%
National income	$35,000,000,000	$11,000,000,000
Taxation, 1917-18, proposed	2,500,000,000	3,000,000,000
Per cent. taxation on national income	7.14%	27.27%
Population	102,000,000	47,000,000
Per capita wealth	$2,451.00	$1,808.00
Per capita debt	16.66	404.20
Per capita income	343.00	234.00
Per capita taxation	24.51	63.80

Pumping Lake Waters

The waters of the Great Lakes are polluted by the drainage of the cities along their shores. Even tho the sewage of Chicago is turned into the Illinois river, the southwestern shore of Lake Michigan is polluted by the drainage of at least a million people. Sewage pollution in Milwaukee travels sometimes as much as 5 miles in recognizable form, and it is estimated that shore pollution may be carried as far as 20 miles.

Intakes for water supplies from the lakes are located out in the lake in depths varying from 20 feet at East Chicago to 60 feet at Milwaukee. Pollution to some extent may reach these intakes from sewers and from boats passing near them.

Emergency intakes near shore are dangerous and interfere seriously with the operation of plants designed for the purer water of the intakes farther out, but they are sometimes necessary on account of the stoppage of the regular flow by accumulations of anchor ice.

Leaks may take place in the intake pipes without revealing themselves until an outbreak of typhoid, as in Evanston in 1912, demands an investigation.

More or less purification of the water is therefore safer than dependence on distance and depth of intake.

In a paper before the Illinois branch of the American Water Works Association Samuel A. Greeley, hydraulic and sanitary engineer, Chicago, details the methods of purification in use in various cities and towns on Lake Michigan and gives some idea of the reliability of the processes under the existing conditions.

The most popular treatment is that with calcium hypochlorite with its nearest colleague, liquid chlorine. Chicago, Milwaukee, Waukegan, Whiting, Hammond, East Chicago, Michigan City are among those using this process. The apparatus required is low in cost and is quickly installed and operated at a low cost. An emergency installation is quickly made and may need but little improvement to fit it for regular use.

One difficulty in applying this method is found in the great variations in the quality of the water to be treated in some plants. Thus at Waukegan the variations according to tests made each four hours by the starch-iodine method show changes in amounts of hypochlorite required for sterilization from 22.37 to 9.65 pounds per million gallons between 7 in the morning and 3 in the afternoon with an increase again later in the day, due to winds and lake currents changing the quality of the water at the intake. The accompanying Table I shows the variations on a number of days in the late winter of 1916, and demonstrates the necessity of keeping close watch of the quality of the water if safety is to be assured. The expense of this watch is large and offsets to a considerable extent the low cost of the treatment itself.

TABLE 1.
WAUKEGAN, ILLINOIS.
POUNDS CALCIUM HYPOCHLORITE PER MILLION GALLONS.

Date 1916.	12 to 4 a. m.	4 to 7 a. m.	7 to 12 noon.	12 to 3 p. m.	3 to 8 p. m.	8 to 12 night.
February 6.	9.45	10.96	22.37	9.65	14.60	16.71
February 3.	7.89	7.55	7.07	7.50	8.07	6.30
February 7.	24.23	11.66	22.20	20.11	10.08	10.71
February 8.	7.90	5.55	13.49	9.69	13.20	13.08
February 9.	7.88	7.58	13.67	17.58	9.16	5.60
February 28.	15.07	13.04	16.66	15.03	15.19	12.85
March 18 ...	11.77	10.00	10.11	9.10	9.84	9.27
March 20 ...	8.24	7.57	7.44	7.54	7.90	7.65
March 22 ...	8.29	8.35	8.13	8.20	9.59	8.20
March 23 ...	6.48	8.74	8.35	7.74	7.62	7.27

Sudden change to emergency intakes with more highly polluted water sometimes strains the method beyond the danger point. Tastes in the water happen frequently in the winter as a consequence.

Rapid sand filtration is in use in Escanaba, Mich.; South Milwaukee, Wis.; Evanston, Ill., etc., the closed pressure type being in use at Lake Forest, Kenilworth and Rogers Park, Ill. The United States Naval Training Station has a slow sand filtration plant.

These plants can take care of marked variations in quality of raw water successfully, and the filtered water, when conditions are particularly bad, can be lightly treated with liquid chlorine and make the results safe and at the same time produce a water which is palatable at all times.

The filtration plant also removes turbidity, microscopic organisms and other like impurities.

It costs more to build and more to operate and requires competent supervision, the latter being required by the sterilization plants also under the lake conditions.

Filtration plants have been recommended for East Chicago, Ind., and Wilmette, Winnetka, North Chicago and Waukegan, Ill., and plans or plants are in progress for Whiting, Ind., and Kenosha, Wis. These plants must be carefully designed for the work to be done, the nature of the pollution being quite different in different towns as well as varying rapidly hour by hour in any one plant. Thus in some places microscopic organisms develop largely and affect the length of runs of filters between washings. Whiting must remove the oily taste coming from a small amount of oil refinery waste, and the creosote taste from the quench water from coke ovens, also the nuisance from glucose factory waste.

Besides the Evanston typhoid epidemic in 1914 due to leakage of intake pipe, there have been outbreaks of typhoid in North Chicago, Waukegan, East Chicago and Milwaukee which have been attributed on more or less definite evidence to the inefficiency of the hypochlorite treatment, especially on a sudden resort to water from an emergency intake when the regular supply was stopped by anchor ice.

Mr. Greeley is therefore recommending filtration plants, usually rapid sand filtration, in order to come nearer to insuring water safe at all times. He cites results obtained in the lake cities having such plants and the opinions of other engineers in accord with his.

His conclusion is that eventually all publiic water supplies from Lake Michigan will be filtered, the plants not yet demonstrated to demand the more thoro treatment to be subjected to careful expert supervision of the chlorine process with routine analyses at frequent intervals during the day to regulate the amount of chlorine properly to the varying conditions.

A Simple Method of Testing Sands.

During the past few years the subject of impurities in sands for mortar and concrete has been receiving rapidly increasing attention from test engineers and inspectors. Tests have been conducted along this line by the Structural Materials Research Laboratory at Lewis Institute, Chicago, and results set forth in a circular entitled, "Colorimetric Tests for Organic Impurities in Sands." This experimental work was carried out in co-operation with committee C-9 on concrete and concrete aggregates, of the American Society for Testing Materials. The comparative ease with which this test may be conducted should make it a practical one for field purposes, and therefore, one of special interest to highway engineers and contractors engaged in concrete work.

This circular will be sent to engineers, contractors and others who may be interested. It was distributed at the Tenth Annual Cement Show in Chicago in connection with an exhibit made by the laboratory illustrating by tests on concrete cylinders the effect of organic impurities in sands.

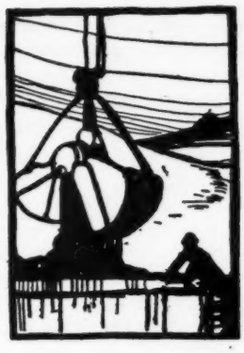
The fact that the sand has passed the colorimetric test does not by itself prove that the sand is suitable for mortar or concrete since its fineness and other characteristics must also be considered, as they affect the strength. The result of the researches, however, indicates that it is a reliable test for organic impurities which are the most common sources of danger in a sand of satisfactory granulometric composition.

Meetings of Organizations

September 24-29, at Santa Rosa, Cal.—League of California Municipalities and Annual Public Welfare Exposition of municipal streets, street and road-making machinery. F. J. Erb, director of exhibits, Pacific Building, San Francisco. H. A. Mason, Secretary, 1120 Crocker Building, San Francisco.

September 27 to 29, at Chicago Norske Klub, 2346 North Kedzie Boulevard, Logan Square, Chicago, Ill.—Informal Congress and Reunion of American and Canadian Engineers and Architects of Norwegian Birth or Descent. Joachim G. Giaver, chairman of local Chicago committee on arrangements.

October 17-18, at St. Cloud, Minn.—League of Minnesota Municipalities. Richard R. Price, Secretary, University of Minnesota, Minneapolis.



MACHINERY AND SUPPLIES

Machine-Dug Trenches for Railway Tracks

The General Engineering & Construction Co., of Rockford, Ill., sub-contractors for municipal street work, have perfected a new type of grading and excavating machine, which seems to meet in a very practical way, certain conditions in street excavation, not met by any other machine.

This machine is particularly adapted to grading in connection with the street paving work, especially where it is desirable or necessary to haul the dirt in dump wagons and where space is limited, as in many points.

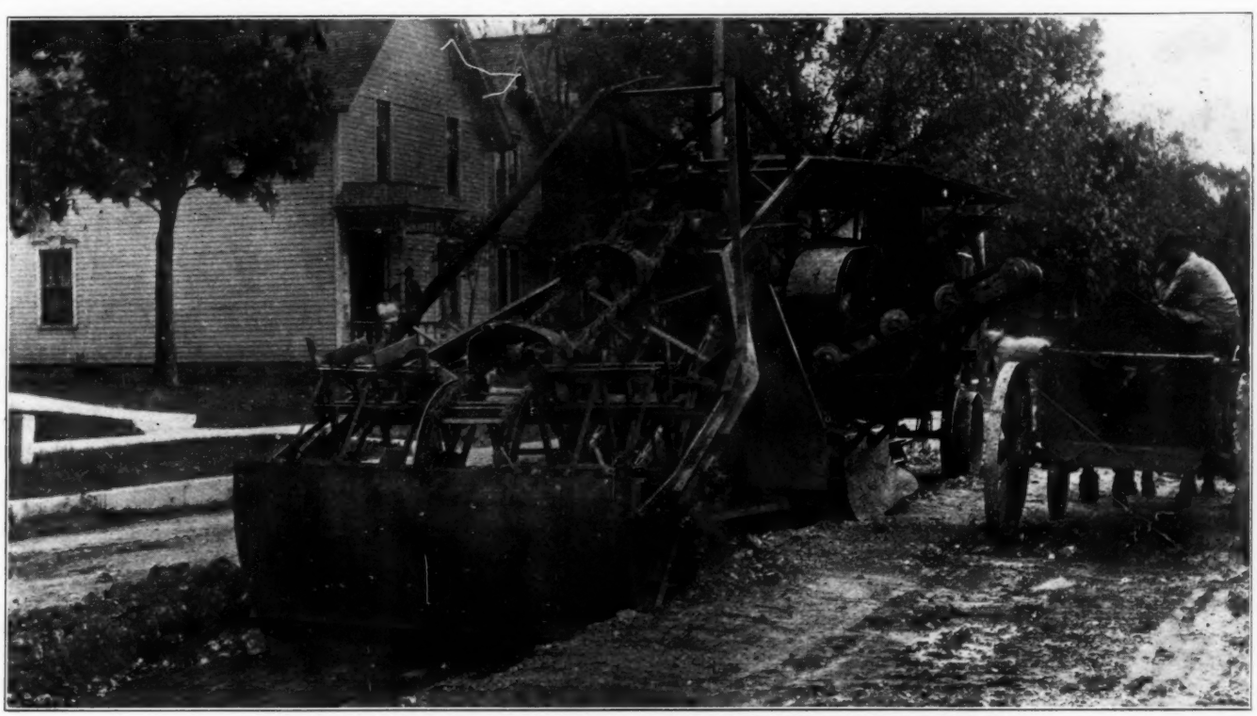
It is also adapted to excavating trench for street railway tracks. This machine cuts a strip 8½ feet wide, and will excavate 2 or 3 inches deep, or as deep as 5½ feet, the cutting wheel working on a boom being instantly adjustable by a screw raising or lowering. An indicator is provided so that the operator can run true to a grade line. The earth is deposited in dump wagons and the production is so uniform that the number of teams can each day be properly proportioned to the length of haul so that there will not be over half a minute lost team time at the machine on each trip. This is one of the points of economy in using the machine.

This machine can be run so as to cut very close to a finished fine grade, saving a considerable amount of expensive hand work. In practice, it is found best to make the outside cuts on street work first, cutting to a line to allow room for the curb and gutter and the forms. On the outside cuts, the excavator is pitched to conform to the crown of the street. If the width of the excavation should be 25½ feet, there would be two outside cuts, one cut in the center with nothing left, and the third and middle cut made flat. If the width of the excavation was less than 25½ feet, the result would be the same.

If the width of the excavation was 27½ feet wide, for instance, there would apparently be 2 feet of the side which could not be handled thru the machine. However, this extra material is taken care of by making the center cut as before, and sufficiently deep so that the 1 foot of surplus material on each side of this cut, can be leveled down and rolled into the center cut.

In practice it has been found desirable to cut slightly below the finished sub-grade, and at the last cut to finish the fine grade at once, by dumping sufficient material from the wagons to level it up to the desired grade and roll at once. Obviously, this is much less work than making a fine grade by removing surface by hand tools.

Material at alley intersections is taken care of by excavating deeper in front of the intersection for 16 to 24 feet, thereafter, to plow the intersection and slip the earth into the extra depth. This machine will work on old macadam streets if the excavation can be made 2 inches. It is seldom neces-



POWER EXCAVATOR ON GRADING JOB FOR STREET RAILWAY TRACK.

sary to root or plow the streets in advance of the machine, as the cutting drum is provided with narrow, sharp cutting teeth. This machine will also handle sand as well as fine material.

In street railway track excavation, the track trench is usually 18 to 20 inches deep and 8½ feet wide. This cut is made in one operation and the spoil put in wagons. If it is railway track work, the track may be removed closely ahead of the machine by jacks, and the trench being completed, new track can be laid directly in back of the machine, so that in case of single track work, the cars can be kept running with only a break and transfer of 150 to 200 feet. About 500 lin. ft. of track trench can be handled per day of 10 hours.

These machines have been run on work both paving and street railway in Illinois in 1914 and 1915, and have proved satisfactory and practical in every case. On one particular job, the machine compared so favorably with a steam shovel on the work, that the steam shovel was dispensed with.

New Locomotive Hopper

We are illustrating a unique device, as devised by J. C. Proctor, Seattle, Wash. This rig is adapted for the conveying of sand and gravel into batch measuring box over the mixer. The material is lifted from auto truck in boxes containing about one yard each, sand in one side and gravel in the other. The material is taken from bottom of hopper by double cup conveyors and is kept separate until deposited in the batch

LOCOMOTIVE HOPPER FOR CHARGING CONCRETE MIXER.

measuring box, at which juncture the cement is added before dumping into the mixer. This operation is repeated as fast as the mixer takes it away. The engine propels the hopper along with the mixer and lifts boxes from the trucks and dumps contents into the hopper, which should hold about three truck loads.

This device keeps material out of the mud and dust and out of the streets and eliminates the men and wheelbarrows.

Tractor Equipped with Hoist

The accompanying illustration shows a modern oil tractor equipped with a hoist as developed at Minneapolis, Minn. This oil motor is of the four-stroke cycle type with four cylinders, cast in pairs, with heads, body and valve chambers all in one solid piece. It has flyball throttling governor which controls the speed of the motor by regulating the fuel supply. A force-feed oil pump forces oil thru copper tubes directly to each cylinder, crank bearing and connecting-rod pin thru centrifugal ring oilers.

OIL TRACTOR RIGGED WITH POWERFUL HOIST.

This oil tractor with hoist is equipped with high-tension, self-starting magneto which requires no batteries. The motor is horizontal with crank shaft extending crosswise of the frame.

It may be stated that the main drive pinion and belt pulley are keyed together in a solid piece upon a sleeve which is provided with a bronze-bushed bearing and runs free upon the engine crank shaft. The power is transmitted from the crank shaft to the belt wheel and pinion thru an expanding two-shoe friction clutch, which is keyed to the crank shaft. The main drive gear is mounted rigidly with transmission gear to a solid sleeve with a bronze bushing which is free to rotate upon the main drive shaft.

The transmission system is without a single extra gear. A single spur pinion on the crank shaft engages the differential and at each end of the differential shaft are the bull pinions which drive the bull gear. The differential shaft runs in a unit bearing, consisting of a solid steel casting, extending the entire width of the frame, babbitted for several inches at each end with a space in the center for oiling. All gearing is covered with a dust-tight case. The machine is reversed by the single movement of a lever operating a simple and ingeniously arranged idler pinion, which remains entirely out of service when the tractor is moving forward.

This machine has the bridge girder frame and the front axle consists of trussed steel bars, and has only a vertical oscillating motion, with the wheels turning on knuckles, as do the wheels of an automobile truck.

It is of interest to note that the centrifugal type flyball governor is housed in an oil-tight, dust-proof, spun-brass case, is geared directly from the cam shaft, and controls the engine within a few revolutions from full load to no load by regulating the fuel supply thru a single lever connection operating directly on the throttle valve. This governor is equipped with an accurate and positive adjusting device which makes it ideal for operating a threshing machine, corn sheller, or any machine requiring steady motion.

The motor is also provided with a hand throttle so that it may be controlled by the operator while running. The cyl-

inders and crank bearings of the motor are lubricated by a multiple forced-feed oil system, the oil being pumped by a positively driven force pump thru individual pipes directly to the cylinders and bearings. This insures perfect lubrication under all conditions and speeds of motor. A splash system of oiling is also used thru the oil basin under the crank shaft, oil being carried in this basin to a level such that the connection rods dip into it at every revolution, filling the entire chamber with an oil spray. Gears and all other parts are lubricated from the main oil reservoir, the oil being carried to the bearings and gears by separate pipes provided with special lubricating valves. Thru this system of oiling, every bearing and gear face on the tractor is lubricated continuously without requiring the attention of the operator.

It may be mentioned that carburetion is secured thru a combination kerosene-gasoline carburetor which has finally made possible the use of lower grade fuels such as kerosene and distillates in this type of internal combustion motor. The carburetor is provided with a double or outer bowl thru which exhaust gases are led by a flexible tube, the consequent heating causing the lower grade fuels to volatilize more readily.

A One-Man Car-Unloader

For unloading sand, limestone and other building materials from gondola cars a new gas engine driven unloader has recently been produced. This is known as the Panama unloader.

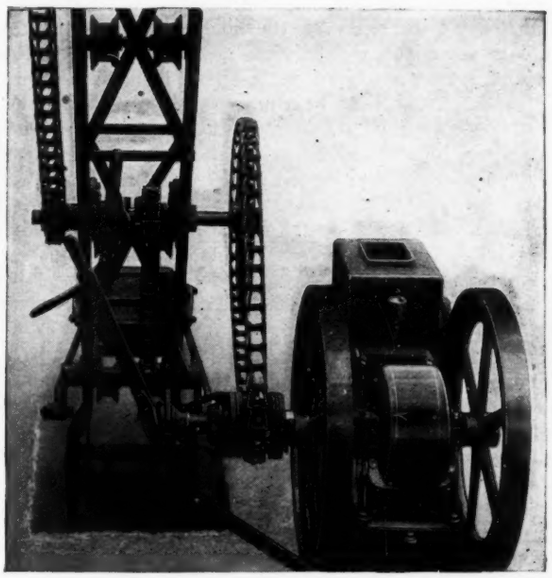
One of the principal features of this unloader is the extreme simplicity. It consists mainly of a movable-bottom steel box which fits between the ties under the track, a bucket conveyor and a 6-h. p. gas engine.

DETAIL OF MOVABLE BOTTOM—BOX OF "PANAMA" UNLOADER.

When in operation the trough is kept filled with stone or sand, which is continuously jogged forward into the carrying buckets by the backward-and-forward movement of the trough bottom. This movable bottom and the buckets are the only moving parts of the outfit, and are easily replaced when worn, and at little cost.

The Panama bin, to which the material is raised, is very strongly constructed and, as will be noted from the attached illustration, is of the center-delivery type, so that the wagons or trucks may be driven directly under it. With this method the wagons load fully and evenly. Three outlets controlled by long levers permit the operator to control the discharge easily.

Aside from erecting the framed-timber bin the only expense in connection with installing the Panama is the slight cost of



POWER PLANT OF "PANAMA" UNLOADER.

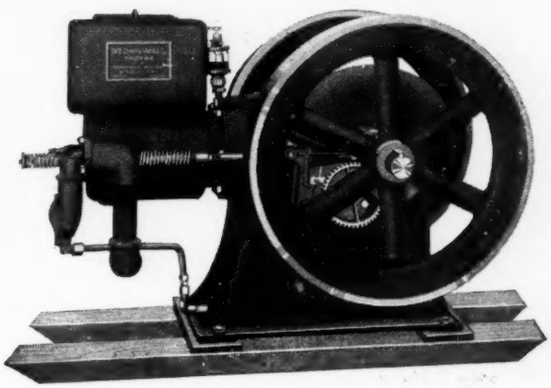
digging a trench under the track for the steel trough, and a pit for the conveyor frame. For the trough a hole a foot deep, 2 feet wide and 8½ feet long is needed. The conveyor frame requires a pit 4 by 4 feet.

It is said that the Panama will completely empty a gondola car of limestone in from 40 to 60 minutes at a cost of not to exceed a cent per cubic yard, or about one-tenth to one-fifteenth the cost of hand unloading. Thus the unloader saves its cost in a very short time.

As the Panama conveyor frame is made in two independent sections it can easily be arranged to load directly from car to the motor truck by using one section only.

Lightweight Contractors' Engine

On account of the unusually light weight of the Brownall Engine, this strong pulling machine has found considerable favor among contractors and makers of contracting machinery. It is the result of more than seven years of engine construction, during which time a special study was made of the requirements necessary to produce an extremely light weight, compact, powerful and lasting engine, adapted to contractors' work. As a result, about 100 lbs. per h.p. of weight



THE LIGHTWEIGHT BROWNALL ENGINE.

was eliminated over former designs, stronger metals of less weight being substituted for cast iron.

High speed is an important factor in lightening the engine. It was found that with the same bore and stroke, at a high speed, more power could be produced, consequently, the flywheel could be reduced in size and weight.

The Brownwall engine on the mixer or other contractors' outfit cuts down the weight from 200 lbs. to 600 lbs. It is of the inclosed crank case type, keeping dust and cement out of the cylinder and main bearing. Gasoline is stored in the base. The engine is built in both the water cooled and air cooled types, either one being desirable and both systems guaranteed cool. The absence of packing on the water cooled type is very important, as any chance for blowout is eliminated. The valves can be taken out and replaced in a few minutes. The entire engine is simple and easily accessible. This engine is made of 1¾-h.p., 3-h.p., 4-h.p., 6-h.p., and 10-h.p.

Trailer "Oil Distributer"

We are illustrating a type of oil trailer tank distributor as manufactured by the Good Roads Machinery Co. This outfit is designed to meet the requirements that come up in spreading oil on county and state jobs where long hauls are necessary, and where pressure distribution is desired, but with larger capacity both for carrying oil and for distributing over wider widths of road surface and in larger quantities than is possible with horse-drawn machines.

The distributing mechanism is similar to that used on the horse-drawn American Monarch distributor, but has two rotary pumps instead of one. This arrangement affords a more flexible control of the amount of material that can be distributed and permits of a much higher pressure.

The standard manifold length is 6 feet, but with the two pumps it is found quite practical to use manifold widths of 8, 12 or even 16 feet, thus saving going over a road twice where the right application of oil is made.

Experience has demonstrated the advantage of generating pressure for distributing the oil by means of the traction of the rear wheels, and this system is used on the trailer, as illustrated. Having in mind the high speed at which these outfits travel along the road, roller chains are used for the pressure generation, and roller bearings on the axles.

Specially constructed heavy springs are also used to take care of the vibration. The great value of the trailer tanks lies in the facility with which they can be handled, especially on narrow roads. With a three or four wheel tractor and a tank trailer, an outfit can be turned around without difficulty on a 12-foot road.

Conveyed by Compressed Air

The village of Highland Park, Mich., bought a Cummer stationary asphalt plant early in the spring, 1916, and during the ensuing season gave it severe usage tests in the mixing of concrete base for 113,000 square yards of street pavements.

"Of this amount," states Mr. E. G. Foster, superintendent of the Department of Public Works, "we surfaced 46,472 yards with asphalt at an average of about 1,000 square yards per day. One of our streets—Hamilton boulevard—was surfaced with 56,400 yards of creosote block. When this is completed, we are assured that it will be one of the most beautiful boulevards in the vicinity of the city of Detroit.

"The Cummer asphalt plant, which proved of such great value in the foregoing work, is equipped with three kettles of 10-ton capacity each, and has a maximum daily yardage of 1,500 square yards. The dryer is mechanically controlled with conveyors which transport the sand and stone into the heater. The mixer also is a mechanically-driven device with mechanical conveyors.

"Our asphalt is heated in kettles and, which is rather unusual, is conveyed to the mixer by compressed air. This enables us to operate the plant with the help of only a few men, about 6 in all, whose duties are to see that the kettles are kept filled with asphalt, and that the fire and the sand-dumping conveyors are provided with sand and stones.

"Haulage from the plant to points where the work was in progress was done with four Kelly-Springfield 6-ton motor trucks. These transported and dumped the mixed asphalt upon the concrete pavement, where a 12-man gang raked, tamped and otherwise prepared the fresh asphalt for the roller.

TRAILER "OIL DISTRIBUTER" OF TYPE ESPECIALLY EFFICIENT ON LONG HAUL JOBS.

"PLUTO" PORTABLE ASPHALT HEATER ON THE JOB.

Portable Asphalt Heater

By means of the portable surface asphalt heater here illustrated, the cost of making repairs on asphalt pavements has been materially reduced and the time required for the work greatly cut down. The machine is composed of a 6-foot by 6-foot iron frame carried on wheels, and provided with a battery of six kerosene burners. When in use, the heat of these burners is directly applied to the paving surface, and can be easily regulated for best results.

More than enough fuel for an 8-hour day is carried in the two kerosene tanks of the machine illustrated. Of the 53 gallons of oil required for a filling, 35 gallons are carried in the main tank and 18 gallons in the auxiliary tank. A cut-out arrangement allows for filling the large tank while operating the smaller one, so that the supply can be replenished without stopping work for an instant.

For easy transportation, this "Pluto" heater can be folded so that the heating hood is carried over the wheels, making the device take the form of a compact trailer.

In operation, the capacity of a 6-foot by 6-foot "Pluto" heater is 36 sq. ft. of asphalt in from 3 to 5 minutes, depending on the thickness of the material and other variable factors. On one Detroit job, where the machine was recently used, the foreman in charge reported that 500 sq. yd. to a depth of 1 inch had been removed in 8 hours. This with a consumption of about 6 gallons of kerosene per hour.

Motor Truck Manhole Pump

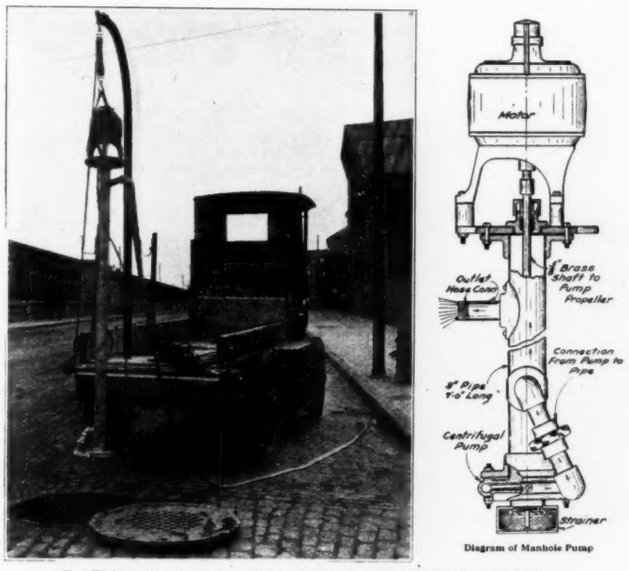
In the spring of the year and after heavy rains, considerable trouble is experienced by the Underground Department of the Rochester Railway and Light Co., because the manholes, which have no drains, are flooded with water above the cables.

The cable ducts connecting the manholes allow the water to flow from manhole to manhole until a number of manholes have become filled, making it necessary to pump the water out before any work can be done on the cables. In the past, a hand pump was used. This was very tedious work, sometimes requiring one or two hours' continuous pumping. It was decided to design an electric-driven pump and use material in the company's stock, if possible.

As shown in the accompanying diagram, a ¼-horsepower 1400 r.p.m. vertical motor and a small centrifugal pump were connected by a 3-inch spiral riveted pipe 7 feet long. The pipe acts as a support for the motor, is long enough so that the pump can be lowered into the water without submerging the motor and at the same time conducts the water from the pump to the street level. The shaft of the motor and the impeller of the pump are connected by a ⅝-inch brass rod running thru the 3-inch pipe.

The complete apparatus weighs about 170 pounds and is supported by a small crane attached to one of the company's trucks. The crane is a small pipe with a long radius bend and hook at one end, so that the pump can be swung over the edge of the truck and lowered into the manhole by means of a block and tackle.

The pump requires only a small amount of power, and the motor is operated by the battery which operates the truck.



LABOR SAVING PORTABLE MANHOLE PUMP.

The utility of the pump is shown by the fact that it will empty a manhole in fifteen minutes, whereas, it would take two men almost an hour to do the same work with a hand pump.

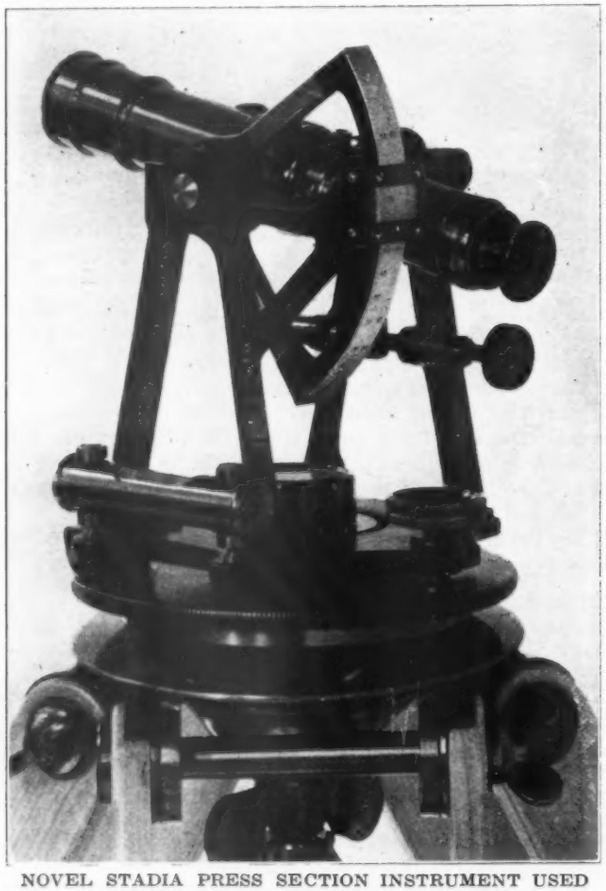
The pump is in operation every day, especially during the rainy season.

The National Safety Council has begun the issue of pamphlets on accident hazards and the best practices for the elimination. The first three are respectively on ladders, stairs and stairways, and boiler rooms. They can be obtained from W. H. Cameron, Secy., 208 S. LaSalle St., Chicago.

Instrument for Measuring Earthwork

By Frank C. Perkins, New York City, N. Y.

The accompanying illustration shows the construction of a novel Stadia cross section instrument which was designed at Troy, N. Y., for the Engineering Board of the Interstate Commission and now in use in the field by their Valuation Engineers. The instrument is unique in that it is the first one designed solely for the purpose of cross sectioning rapidly and accurately.



NOVEL STADIA PRESS SECTION INSTRUMENT USED BY NEW YORK VALUATION ENGINEERS.

This Stadia instrument for measuring earthwork with Beaman Arc is equipped with a telescope which has the usual movements and is fitted with stadia wires. The plate on which the telescope is mounted is fitted to a "Johnson" head, which is leveled by sliding on a concave surface and clamped by the upper wing underneath. The whole moves in azimuth and is clamped by the lower nut underneath. The arc graduations are so spaced and figured as to give simple multiples of the rod interval, thus determining rapidly and without intricate calculations, the precise difference in elevation and reduced horizontal distance.

In order to use this instrument, it is necessary to set the tripod in the middle of the road bed, unless the view of the road is obstructed by the bank, and in this case, the tripod is set up near enough to the edge of the bank to see the rod and set up again for the other side, noting the distance between settings.

It is then required to level the plate by the circular level, clamp the same and orient to a sight on rod held plumb and in a line at right angles to axis of the prism to be measured. It is necessary then to level more carefully by the tubular level, using the single leveling screw, and this establishes the zero which governs all readings. The stadia intercept on the rod is then read when the index of the arc coincides with any division whatever, provided the wires are on the rod. It is then possible to note on the arc V, the arc reading, intercept, and middle wire reading, and from the opposite index, to note from arc H, the nearest per cent reading. This embraces all the field work at one station, when the instrument is carried to next station, usually 100 feet.

The clerical work necessary is to compute the number of cubic yards in the prism, or the square feet in the section multiplied by 100/27. To make the computations, for vertical, the arc reading minus 50 is multiplied by the intercept on the rod. There it is required to add the reading of middle wire on the rod and subtract the height of instrument.

For horizontal, the process is to multiply the observed distance (intercept x 100) by the percentage and then the observed distance minus the product is the true distance. The area of section will be one-half the sum of the vertical by the distance between them, subtracting the two triangles. This result in square feet is multiplied by 100/27 and we have the volume of the prism 100 feet long in cubic yards.

Steam Shovel Lifts Itself

The accompanying illustration shows the Osgood "18" ¾-yard traction revolving steam shovel and its method of lifting itself so that planking may be used if necessary.

Probably the most difficult situation that confronts the contractor operating steam shovels in wet or soft ground is to keep the shovel from becoming mired. It is a hard, endless job when it becomes necessary to jack the shovel up so that

OSGOOD SHOVEL LIFTED FOR LAYING SOME PLANKING.

planking may be used. The Osgood ¾-yard traction revolving steam shovel can be raised several inches off the ground by its own power so that planking may be used. This is done by dropping the dipper to the ground and starting the crowding or boom engines, which forces the dipper handle in a downward direction, raising wheel from ground.

Automatic Features Increase Mixer Yardage

With the steadily increasing cost of labor, the time element on the concrete job is becoming more and more important. Not only does the contractor have to speed up his work, but he has also to do each job with fewer men than ever. This pressure of time and men has brought the good points of the concrete paver with many automatic features to the front more strongly than ever, as the opinions of a number of leading contractors testify.

Operating information recently furnished by Culbertson & Culbertson, Richmond, Ind., accurately reflects the economical advantage of automatic action features in actual practice.

"We have been using two Koehrings on our work," states Mr. R. G. Culbertson. "One a No. 14 bought over four years ago and the other a No. 16, 1916 model.

"With the four-year-old machine we have been putting down an average of 600 sq. yd. per 10-hour day, working 13 men. This paver was equipped with an old-style loading skip, accommodating one wheelbarrow at a time. There was no difficulty of any kind encountered in the use of this machine.

"With the last year's No. 16 model, we were able to put in an average of 900 yards of 6-inch foundation per 10-hour day. It is admitted that this cannot be considered a fair working capacity for a paver, but on our particular jobs the handling of the work was handicapped by so many unusual conditions that it was not possible to secure uniformly greater average results in the way of yardage. The paver handled a 2-sack batch proportioned 1—2½—5; the sand and gravel being dumped into the loading skip from two lines of wheelbarrows. The operation of this machine ordinarily was all that could be desired, and we were especially pleased with its loading, the uniform mixing of the materials, the excellent tractive pull, which made planking necessary only at rare intervals on the very softest ground, and the steaming quality of the boiler. The discharge and the handling of boom and bucket were all that could be expected.

"The consistency of the mix was good in both machines, and each mixer was able to take care of all the material which could be delivered to it, at the same time keeping the charge in the drum the length of time required by the specifications. So far as our observation goes, the working of the machinery is as smooth as that of a stationary engine, and there was no perceptible depreciation at the end of the season's work."

On Illinois road work the Koehring automatic concrete paver has also shown up to excellent advantage. Prendergast-Clark Construction Co., St. Louis, Mo., used a No. 16 on a considerable amount of paving in Vermilion county and according to Edw. Prendergast, of that company, held the speed record for Vermilion county work last year.

"The mix on our work," states Mr. Prendergast, "was 1 cement, 2 sand and 3½ crushed rock or gravel. With the batch meter attachment, we could mix the concrete to any consistency desired, distributing quickly and easily within the radius of the boom. We consider the boom-and-bucket method of distribution far superior to chutes, as concrete mixed fairly dry cannot be as economically distributed with a chute.

"All of the past year, our daily average was 604 sq. yd. for a 10-hour day, which was the highest average of any mixer in the county. There were nine contractors in the country all working under approximately the same conditions.

"While we do not consider ours a large yardage (only about one-half of what the machine can do), it was the best in competition with eight other machines.

"All of the material for the Vermilion county work was brought up on an industrial railway truck and distributed in long piles ahead of the mixer. Sometimes three or four miles of material were on the ground. This provided plenty of material near the mixer for the wheelbarrows to carry and dump into the loading skip.

"The automatic features of our machine work nicely and are a decided advantage. There is no pounding on the back of the skip, as it dumps clean every time and never clogs. This type of machine has in our work operated very nicely and our repair bills have been very small."

A Powerful Pole Jack

To make easy the work of pulling and straightening poles a special pole jack has been devised, and is now being sold under the name of the No. 318 Simplex pole jack. This device, which has a capacity of 15 tons with a lift of 2 feet, pivots on its base and pulls the largest pole from solid ground in but a fraction of the time required by former methods.

No matter what the weather conditions may be, it is claimed that no digging around the pole is necessary. As shown in the accompanying photograph, the I-beam base of the jack is placed beside the pole, the jack is set upon it and the steel chain slung around the pole and pulled tight thru the pear-shaped link. Then the lever is operated. The jack literally jumps the pole away from the earth.

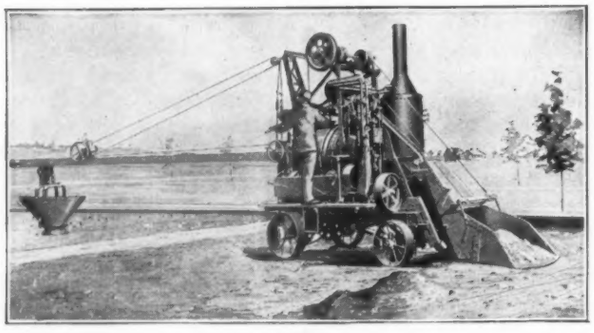
SIMPLEX POLE JACK LIFTING 40-FOOT POLE.

On account of the enormous leverage and great strength, only a few minutes are required for the entire operation. In fact, the No. 318 is said to hold the record for pulling 40-foot poles.

In straightening poles with the No. 318 Simplex, only one man is required. The I-beam base is dropped on the ground a short distance from the pole—the jack is placed thereon and leaned against the pole at an angle of about 45 degrees. With the bar in one of the two sockets, the pole is forced back a notch at a time to the exact position desired. When straight, the bar is removed and used to tamp, while the jack holds the pole in place. No pike poles are necessary.

"Standard" Street Paving Mixer

A medium sized paving mixer having a number of unique features has been placed on the market by the Standard Scale & Supply Co., Pittsburg, Pa., recently. This mixer has a capacity of 11 cu. ft. of unmixed or 9 cu. ft. of mixed material per batch. It is equipped with skip loader, steam engine and boiler and either a sectional distributing spout or a distributing boom and bucket. The bucket has a bottom discharge,



NEW STEAM PAVING MIXER.

which, while delivering, also spreads the concrete so as to materially lessen the hand work of leveling. The boom has an effective length of 20 feet and swings horizontally thru one complete half circle. All movements, including the opening and closing of the discharge, are controlled from the operator's platform. The machine is designed to equalize the weight on the four ground wheels.

A New Adjustable Paving Gage

All of the difficulties attendant upon the use of the ordinary strike board or template have apparently disappeared with the general introduction of an especially accurate steel street gage. This adjustable but rigid gage can be regulated for any street width and any crown. It serves as a gage for preparing the sub-grade, and for obtaining the required thickness of concrete, also finding use as a template and as a bridge from which the finishers can work.

An especially ingenious feature of this gage, which has just now been perfected, adds interest to the appliance at this time. This is the one-man propelling attachment. By means of this device, one man riding in the center of the gage can easily propel the whole device backward or forward at will, moving it much more smoothly than would be possible with any rope pull system. Two speeds are provided, a low for the heavy pulling made necessary when striking off a concrete base, and a high for running backward, and for striking off light materials.

Two templates are provided with each gage. Both are steel shod, and are fastened to the mast in the center of the gage, being attached at the outer end to the steel extension plates. On each side of the templates are trestle rods that hold the gage rigid, adjustable nuts being provided with lock nuts to set and hold the templates to the desired crown. From 2 inches to 4 feet can easily be added to the length of any gage by drawing out the extension plates. When the adjustment desired exceeds 4 feet, it is only necessary to procure new templates of such dimensions as will make the machine the desired width.

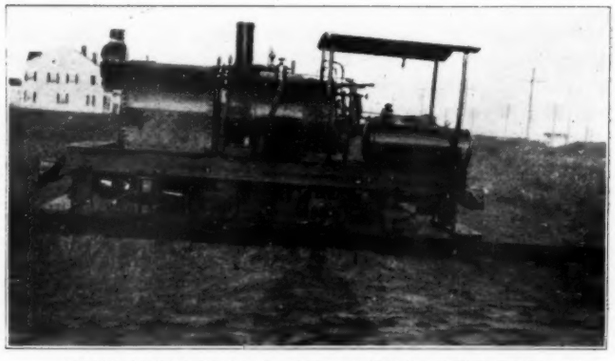
The improved device is known as the Roughen adjustable paving gage.

New Type Steam Locomotive

We are illustrating a new type of contractor's steam locomotive, the machinery or engine parts of which are all confined to one unit, so small and compact that it can be installed in the narrowest gage locomotives. The engine unit includes such features as roller bearings, drop forged parts thruout, and the highest grade material and workmanshiip and all working parts are enclosed in an oil-tight dust-proof case.

The boiler is of the horizontal type with shell and firebox head of one piece of pressed steel, and smokebox head welded in. The shell is wound with several layers of piano wire, thus giving it great strength without excessive weight. The tubes are expanded into the front head and brazed into the rear head from the inside of the boiler by a patented process.

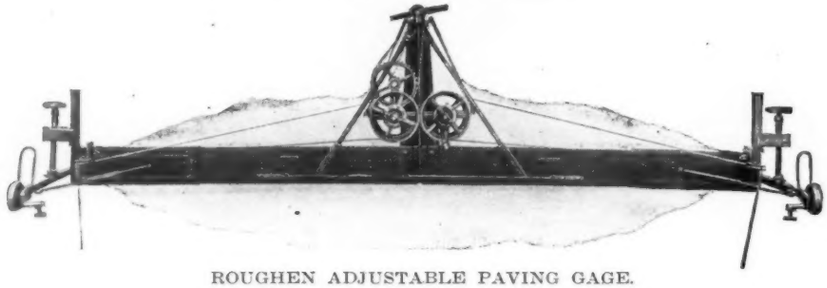
The fire is so distributed that it gives maximum heat to the lower tubes, and only a comparatively low heat to the tubes above the center of the boiler, or those tubes not under water. In other words, there are tubes where stay bolts are usually employed, and this feature gives superheated steam without the addition of superheaters. There are no stays, seams or rivets.



CONTRACTOR'S NARROW GAGE LOCOMOTIVE.

The boiler plant is extremely compact, absolutely safe, easily cleaned and so designed that all the tubes may be removed and replaced in one unit when necessary in from one to two hours' time. A steam pressure of from 300 to 350 pounds is carried and at this pressure, the factor of safety is at least 10. The boiler may be fired from cold in 10 to 30 minutes, or fired instantly after a one hour's stand.

These features furnish the contractor with a locomotive that will run on any fuel, from gasoline and kerosene to crude oil, or coal or wood, a locomotive that will give no smoke or sparks when burning kerosene or fuel oil. This type of Bell locomotive may be started quickly and has the speed of the direct connected locomotive combined with the power of the geared locomotive.



ROUGHEN ADJUSTABLE PAVING GAGE.

Two-Mile Haul Saved by Drag-Line

Mills & Baker, contractors of Casper, Wyo., have secured a big gravel-hauling contract, and the accompanying illustrations show how an ingeniously arranged drag-line outfit saved them 2 miles extra haulage on every trip.

The installation is located slightly less than 2 miles west of the town of Casper. It was found that material on the near bank of the river contains too much silt and loam for use of making concrete, but that material on the further bank holds ingredients in the rightful proportions.

The Mills & Baker plant is installed to both load and haul the gravel from the far side of the river, saving a 2-mile haul from the nearest ford, which is a full mile upstream from the town where the mixing has to be done.

A 1-yard back-dump Pioneer excavating bucket is employed and the pole is 12 by 12 Douglas fir, spliced in the middle at the spider, which is itself 7 feet across between tension rods. These tension rods are 1⅛ inches in diameter and are equipped with turn buckles for taking up the stretch in the rods. The slip is reduced to almost nothing by shoes at both ends of the rod, fastened firmly to the pole.

All blocks at the top of the pole are hitched with three loops of ⅞-inch steel cable and have worked perfectly ever since first being installed. The bucket operates on a 1⅛-inch Hercules wire rope, 600 feet in length. The drag cable is ⅝ inch in diameter and of the same make as the rope. The blocks are of unusually large diameter and self-lubricating. Five guy wires, each 1 inch in diameter, are provided to resist the strain on the large track cable. This is necessary for the reason that the bucket and load weighs about 5,500 pounds.

The tension and drag cables are operated by a boiler, which burns fuel oil, together with a 40-h.p. double-drum hoisting engine. A hoisting engineer and a fireman are the only men needed for the management of this equipment.

The round-trip across-river haul averages only about 2.5 minutes.

The unusually low construction of the bin was so made with an eye to later adding a screening equipment. Gravel from the bin is dumped by gravity directly into the wagons by a chute. Mills & Baker procured their equipment from H. W. Moore & Company of Denver, Colo., who also attended to the installing of same.

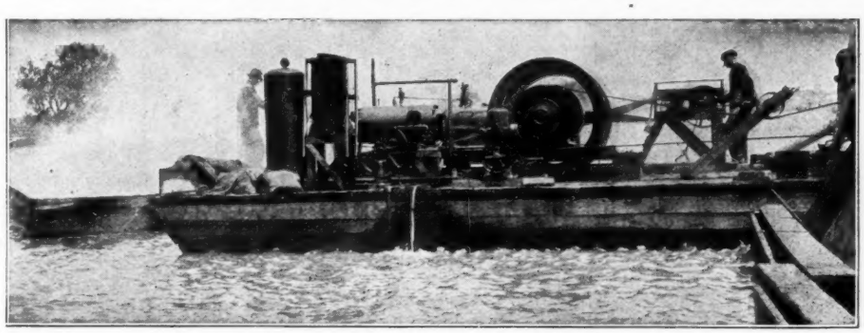
Oil Engine Sand Pumper

To secure clean sand in large quantities the Platte Gravel Co., of Nebraska, has put in service a 50-h.p. oil engine and rotary sand pump which are belt connected and carried on a large scow. Sand is drawn from the bed of the Platte thru a suction pipe, passing thru the pump and then thru a pipe line to the bank of the river, from whence it is carried to the top of a head-frame where the sand, gravel and water are thrown against a screen.

The size of the gravel allowed to pass thru with the sand is determined by the size of the screen mesh. Having passed thru the screen, the sand is promptly loaded into railroad cars, the water returning to the river.

The engine, which is a product of the Chicago Pneumatic Tool Co., has been in operation for more than a year and in continuous operation during the summer season last year without even a roof placed over it, or any protection whatever from the weather.

The outfit is working on an average of fourteen hours per day and is looked after by workmen having no engineering experience.



OIL ENGINE SAND PUMPER.

Field Telephone for Road Work

Contractors on the lookout for short-cuts will find of interest the application of the telephone to road work as recently made by one of the contractors on a section of the Vermilion county (Illinois) bond roads.

Working in conjunction with the Granite City Lime and Cement Co., contractors for the section, the telephone company spliced drop lines from one of the party lines so that a connection was available about every 1,000 feet.

The telephone instrument supplied was provided with an extra loud gong so that it could easily be heard at long distance and above the grind of the mixer. All of the apparatus was enclosed in a weather-proof box, and the box was suspended by a spike from one of the posts.

As the work progressed the box was carried forward to the most convenient lead, and was hung in place on a post. Clips provided for making connection made splicing unnecessary and always insured a good connection.

The telephone used in this way much more than paid for itself, as it enabled the office to keep constantly in touch with the job, and cut in two the time necessary for securing repair parts. Delays incident to shortage of material were completely avoided.

Municipal Research

The New York Bureau of Municipal Research worked on twenty-one assignments during 1916, including all kinds of investigations from general surveys of the city and county governments of San Francisco; Columbus, Ohio; Plainfield, N. J.; North Adams, Mass.; to audits of accounts of departments in such cities as Jamestown, N. Y. The work was done at the instance of city, county or institution governments at the expense of the administrations or of public spirited citizens' organizations.

Paulina, Iowa, Electric Light Plant

Paulina, Iowa, has an electric light plant operated by oil engine of which the following is a description:

The plant consists of one 50-h.p. 2-cylinder horizontal Mietz & Weiss oil engine operating at 275 r.p.m., directly coupled to a 30-kw. generator by means of a flexible coupling of the Mietz & Weiss type. The generator is a 110-220-volt 3-wire machine.

The town of Paulina has approximately 1,000 inhabitants. The plant supplies light for the town and power for one moving picture show.

The streets are lighted with 149 tungsten lamps; those in the residence portion being either on side brickets or center suspended. In the business section 5-light electroliers are used. The plant was put into operation about October 1, 1910, and has been in continuous operation ever since. The contract for installing this plant was taken by the Inter-

state Electric and Manufacturing Co., and the plant was installed complete, including pole line, power house, oil tank, engine, generator, switchboard and all necessary appliances, and turned over to the city in operating condition.

The following information regarding the cost of operating the plant is taken from an annual report of the plant:

Received for electric light (This item does not include any charge whatever for the 149 street lamps.)	$3,793.95
—Expenses—	
Salary for superintendent of public works	1,320.00
Repairs for light plant, including miscellaneous supplies, etc.	65.58
Fuel for light plant	339.63
Lubricating oil for light plant	43.98
Total cost of operation	$1,769.19
Gross profit for the year	$2,024.76

About $1,500 worth of street lighting was furnished during the year which would make the total profit for the year about $3,500.

This plant has proven very economical to operate and has given very satisfactory service. It has an excellent record for its continuous run without trouble.

A similar engine of 18-h.p. for pumping city water has been installed since the electric light plant has demonstrated its value.

Trade Publications

Viking power pumping units for pumping road oils and asphaltic compounds are well described and experience with them is detailed in a circular issued by the Schirmer-Frensdorf Co., Cleveland, O.

The low-priced big-money maker for the contractor, known as the "Dandie" mixer is exploited in a striking circular of the Koehring Machine Co., Milwaukee, Wis.

"Modern Building," a periodical devoted to the manufactures of the Trussed Concrete Steel Co., Youngstown, O., is a real magazine of much interest and value on its subject.

The National Lumber Manufacturers' Association, 925 Lumber Exchange, Chicago, Ill., has issued Technical Letter No. 8 on standard specifications for creosoted wood block pavement, which is accompanied by a substantial reprint of the specifications adopted in October by the American Society of Municipal Improvements.

The Gramm-Bernstein Motor Truck Co., Lima, O., have issued a new catalog of their line of one to six-ton trucks and the many uses to which they have been put. This truck is a pioneer, having been manufactured for 16 years and kept in the fore front of the procession all the time.

Extension of bituminous road building into country districts, remote from permanent plants, has created the need for easily portable asphalt mixing plants. It is to meet this need that the Iroquois Works of The Barber Asphalt Paving Company has designed several types of plants, ranging from 800 square yards to much larger capacity. These plants and their operation are described in an illustrated bulletin (No. 2A) just issued by the Iroquois Works, Buffalo, N. Y.

Fighting the flameless fire by the use of rust-inhibitive Antoxide is described in a booklet of Harrison Bros. & Co., Philadelphia, Pa.

Official Index to State Legislation, 1917, subscription $2.00 for the year. F. O. Poole, Secretary of Joint Committee on National Legislative Information Service, 42 West 44th street, New York.

The National Paving Brick Manufacturers' Association has issued an edition of the specifications for various types of vitrified brick street and road pavements in a single bound volume.

Federal Traffic News gives the monthly news regarding Federal motor trucks, made by the Federal Motor Truck Co., Detroit, Mich.

The sixth of the series of booklets issued by the Sun Co., is devoted to filling and shipping oil, mainly to wooden barrels.

Money makers for the road contractor are shown in a new circular of the Austin-Western Road Machinery Co., Chicago, Ill., and include traction grader, kerosene motor roller, tandem pavement roller, portable crushing plant, pressure road oiler and scarifier.

Bulletin 43503 of the General Electric Co. is a story of the application of Novalux units to ornamental street lighting, told mainly in pictures, which should be a valuable guide in the study of modern street lighting units.

A series of booklets issued by The Barrett Company tell "How a Tarvia Macadam Roadway Is Constructed," how "Tarvia Preserves Roads and Prevents Dust," and the characteristics and methods of use of "Tarvia B" and "Tarvia X."

Publications Received

Unification of Local Governments in Chicago, a report prepared by the Chicago Bureau of Public Efficiency, Harris S. Keeler, Director, 315 Plymouth Court, Chicago, Ill.

Colorimetric Test for Organic Impurities in Sands, by D. A. Abrams, professor in charge of laboratory, and Oscar E. Harder, chemist. Lewis Institute, Chicago, Ill.

Control of Corporate Finance, by Louie H. Oberreich, being bulletin No. 10 of the Indiana Bureau of Legislative Information, Indianapolis, Ind.

The Trend of Legislation for Public Health, by Arthur Connors, being bulletin No. 9 of the Indiana Bureau of Legislative Information, State House, Indianapolis, Ind.

Road Material Surveys in 1914, by L. Reinecke, being Memoir 85 of the Canadian Department of Mines, Ottawa, Ont.

Investigations of Gravel for Road Surfacing, by T. R. Agg, being bulletin 45 of the Engineering Experiment Station, Ames, Iowa.

The Traction Resistance on Curves of a 28-ton Electric Car, by Edward C. Schmidt and Harold H. Dunn, being bulletin 92 of the Engineering Experiment Station, Univ. of Illinois, Urbana.

The United States Government Specification for Portland Cement is published in Circular No. 33 of the United States Bureau of Standards, Washington, D. C., and is for sale by the Superintendent of Documents, Government Printing Office at 10 cents. The specification has been adopted by the American Society for Testing Materials.

The Elements of State Budget Making is the subject of issue No. 80 of the Bureau of Municipal Research of New York.

The Year Book of the American Society of Civil Engineers gives lists of its various classes of its 8,225 members, requiring 371 pages.

Folwell's Municipal Improvements, $3.50 net. John Wiley & Sons, New York.

"City Residential Land Development" is a selection of 27 of the plans for laying out 160 acres of land for residential purposes, which were presented by competitors for prizes offered by the City Club of Chicago. Cloth, royal octavo, 146 pages, $3 plus postage. University of Chicago Press, Chicago, Illinois.

The American Water Works Association has printed in booklet form its standard specifications for hydrants and valves, as adopted in 1913 and revised in 1916.

FIRE DEPARTMENT

Chicago Company Sets Speed Record

What is said by officials of the fire departments to be a world's record in an official speed test in responding to an alarm and getting into action to fight an imaginary fire was established recently by the members of engine company No. 48 at Fortieth and Dearborn streets, Chicago, Ill.

At the command of Assistant Chief E. J. Buckley, department inspector, the firemen leaped from their beds into fire togs and within twenty-one seconds had coupled their engine to the fire hydrant outside their quarters and were throwing a stream of water with 100 pounds pressure from a lead of hose 300 feet in length.

Captain James Hughes and Lieutenant Thomas Tuite are the commanding officers of the company performing the record feat.

Los Angeles Fires Cut 50%

Since the organization of the Bureau of Fire Prevention and Public Safety of Los Angeles, Cal., about six months ago, fires in that city have been reduced by at least 50 per cent. The great decrease in fire loss is attributed partly to the fact that the bureau has strictly enforced the regulation requiring basements to be kept clean, and has also seen to the installation of automatic sprinkler systems and fireproof partitions where necessary.

Fifteen engine companies are stationed in the three fire districts of the city, each furnishing an officer for inspection. As the companies work on the two-platoon system there are fifteen of these men on the job every day, each having his individual map, and each being directly responsible for the condition of buildings in the territory he covers.

When this bureau went into effect, conditions that were almost unbelieveable were found in the downtown districts, especially as to basements of grocery stores, warehouses, dry goods stores, etc., where boxes and rubbish would be piled up so far as to even block exits, the results being in case of fire the loss of life, if not by fire, thru panic. In this branch of the work the department eliminated all such existing conditions within such a short time, until now it is almost impossible to find basements of any kind that are in the least extra hazardous.

Only a short time ago, one of the most stubborn fires that has occurred in many months resulted from a gasoline explosion in a downtown basement of a cleaning establishment. Just two weeks previous to this fire, the chief inspector, while in this very basement on a trip of inspection, prophesied that here would be the next disastrous fire. This was one of the worst fires the department has had to fight in the downtown section, resulting in the injury of fourteen firemen.

Gilbert, Minn., Tests Jeffery Quad

In a pumping test recently made by the Gilbert (Minn.) fire department, a newly purchased Jeffery Quad fire truck showed an efficiency that even exceeded the expectation of the purchasers.

During the course of this test the Pagel pump threw 496 gallons of water per minute thru the nozzle at 180 pounds

REO TWO-TON MODEL J FIRE TRUCK "ON THE JOB."

pressure and 590 gallons per minute thru two lines of hose and two nozzles at 148 pounds pressure, much exceeding the guaranty of 500 gallons per minute at 120 pounds pressure. This was done without undue engine speed and no apparent effort on the part of the machine.

The machine is what is known as a triple combination pumper and chemical, with hose body, having a capacity of 1,200 feet of hose. The machine will supply pressure in the upper part of town, where the head is not sufficient from the water tank to provide a stream sufficient to quench fires. The grade-climbing and snow-bucking ability of this machine and its ability to supply pressure gives Gilbert a machine which will provide it with ample protection from serious fires.

Detachable Fire Hook

The inventor of a recently patented detachable fire-ladder hook claims that his device has features of such value as to replace in a great degree the permanently attached hook and ladder equipment. This new aid to fire fighting was patented by Howard M. Lucas, of the Canal Zone, Panama.

Mr. Lucas' hook is a very solidly built and simple arrangement, consisting of two side bars hooked at one end to grip the window seat, and at the other to support one of the ladder rungs, these bars being substantially joined by two rods. A revolving member turning around the upper rod is provided with hooks which fasten one of the rungs of the ladder firmly in place. This construction is made plain in the accompanying illustration.

Practically any size or length of ladder can be used in connection with this hook. On trials made with 30-foot ladders, the device has been found to work to perfection, permitting the scaling of a wall to a third or four-story window. Use has also been made of the hook as an adjunct to a life-line, providing quickly a very solid anchorage.

On tests made with the detachable hook a total weight of 1,150 pounds was suspended from the device. Even under this heavy weight, the iron showed no signs of giving way, nor did the hooks give any evidence of slipping out of place.

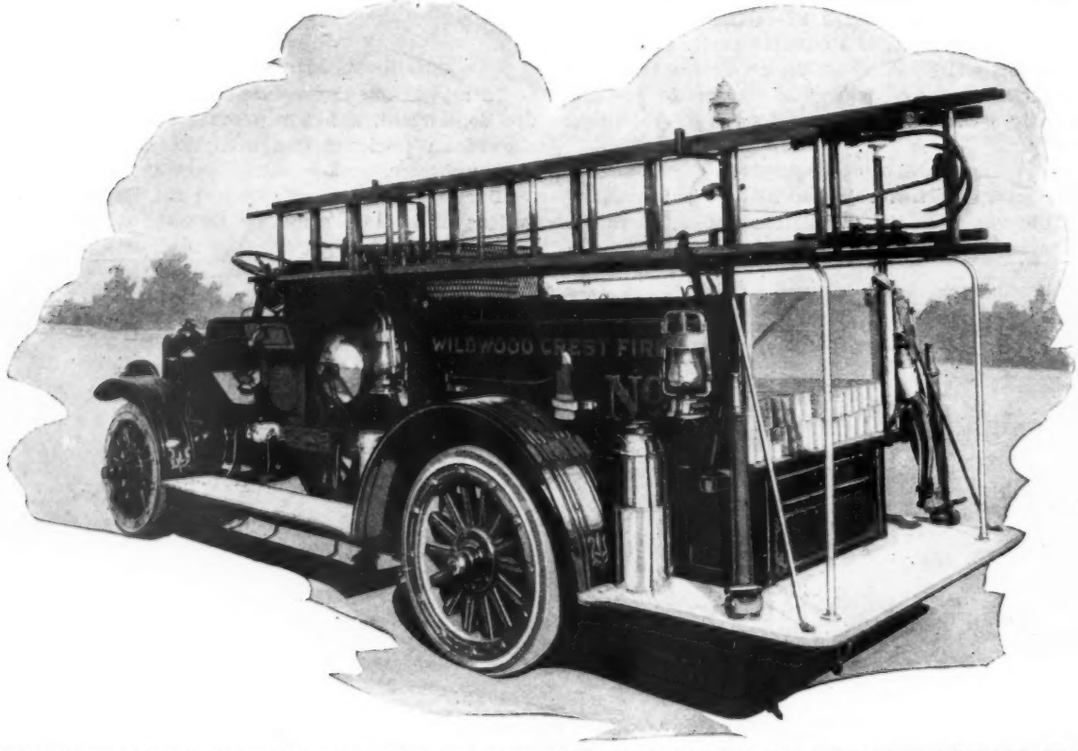
HARLEY-DAVIDSON MOTORCYCLE EQUIPPED WITH FOUR PYRENE CHEMICAL FIRE EXTINGUISHERS. ABLE TO DODGE THRU CONGESTED TRAFFIC AHEAD OF BIGGER APPARATUS AND ARRIVE IN TIME TO CHECK BLAZE WHILE IT IS STILL IN ITS INCIPIENCY.

A considerable saving is claimed on behalf of the new invention on account of the fact that a broken hook does not mean a discarded ladder.

Mechanical Lungs for Protection of Firemen

A recent invention is a smoke-mask suit for the protection of fire-fighters. It operates on the same principle as the human lungs. A small oxygen tank is carried in a pocket attached to the suit and with this are connected two tubes, one of which goes to the wearer's mouth and the other to his nose. Numerous other air-circulating tubes connected with the wearer's nose are provided thru the suit.

Exhalations from the wearer's mouth are transmitted to the tank and there come into contact with the oxygen.



GRAMM-BERNSTEIN COMBINATION HOSE AND CHEMICAL AS OPERATED BY CITY OF WILDWOOD CREST.